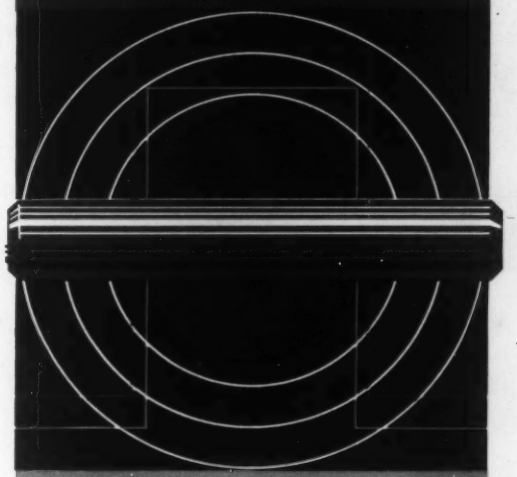
NOVEMBER 14, 1957

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Pin Fasteners

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FARNSWORTH

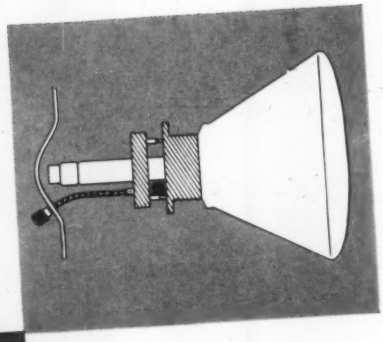
S. S. White

Flexible Shafts Make Operations Easier!

The manufacturer of this hue control for a color TV set uses a standard S.S. WHITE FLEXIBLE SHAFT to cope with a 90° turn. The shaft needs no alignment . . . can be quickly and easily installed. Costs are lower . . . manufacturing is simpler . . . assembly operations are easier, faster.

You can often reduce a complex system of gearing, universals and other parts to ONE FLEXIBLE SHAFT! Flexible shafts also make better designs possible . . . allowing new freedom in locating connected members to save space and facilitate operation and servicing.

For many years, these versatile shafts have been making industrial operations easier. They are tough and rugged . . . yet have the sensitivity you need for delicate adjustments. Design engineers and manufacturers discover new uses for S.S. WHITE FLEXIBLE SHAFTS every day. Can your product be improved by a simple . . . better . . . less costly way of transmitting power or remote control? Our engineers will be glad to work out a flexible shaft application with you. Just write to



USEFUL DATA on how to select and apply flexible shafts. Write for Bulletin 5601.

S. S. White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. White Industrial Division, Dept. 4, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

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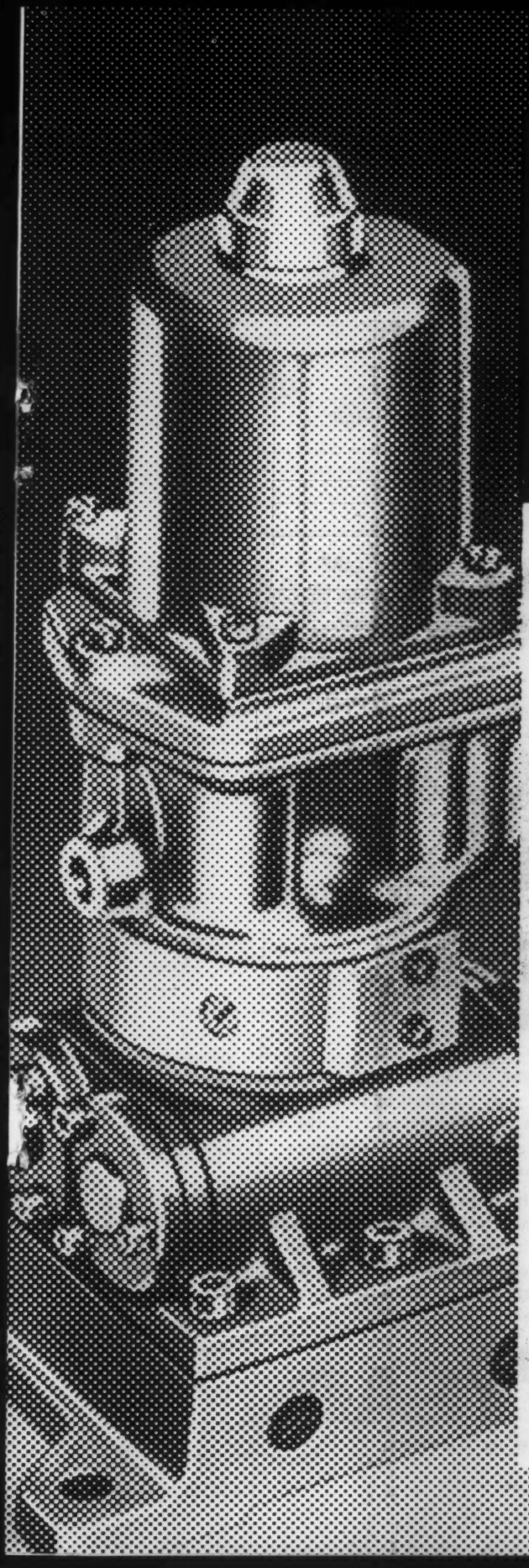
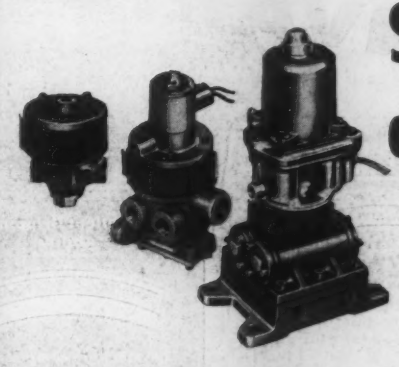


NEW–A totally different type momentary!

Ross Skyline **Double Stroke adapter**



Each time the single solenoid strokes the valve reverses and stays put

An air operated model is also available with which the valve reverses and stays "put" with every air impulse (pressurizing and exhausting) delivered to the single pipe opening in the head. The secret is a two part cycle in the adapter wafer which inserts between any skyline head and any skyline body. Hundreds of applications. Save space. Save cost. Save maintenance. *Do jobs never before possible.* Write for full details in bulletin 316.

Air Controls With Engineering and Ingenuity

Ross OPERATING VALVE COMPANY

109 EAST GOLDEN GATE AVENUE • DETROIT 3, MICH.

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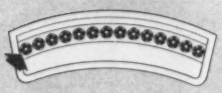
Positive Load Transfer

The special "floating gum" insulating section transfers the load to the carrying cords—prevents chafing.

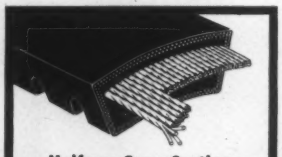
True Dimensional Stability



It's muscled by the exclusive Triple-Tempered (3-T) Cord to give you true dimensional stability in storage and in service.

Highest Transverse Rigidity

The special compression section of fiber-reinforced synthetic rubber strongly resists dishing under side pressure—protects from undue fatigue.



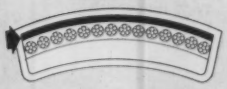
Uniform Cross Section

Precision molding assures an always uniform cross section throughout the length of each belt.

NOW— AN INVARIABLE CURE

to variable speed drive headaches

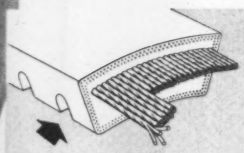
Assured Balance of Yield



The special "cool-running" tension section makes the top of the belt yield in exactly the opposite direction as the bottom—equalizes pull on either side.

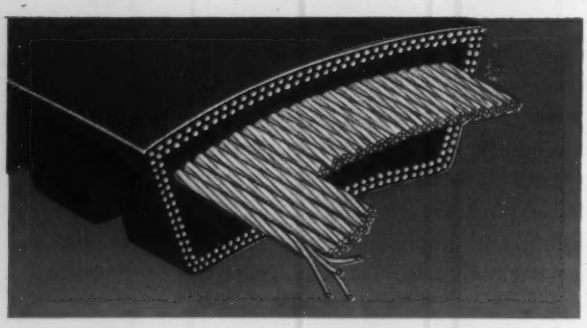
Excellent Gripping Ability

The specially compounded, highly abrasion-resistant cover assures a strong, uniform grip on both faces of the sheave.



Controlled Flexibility

Completely uniform notching gives you the flexibility to bend over small pulleys—without sacrifice of cross-rigidity or strength.



HERE, at last, is a belt with all the answers to one of your toughest of belting problems: harnessing variable speed drives. It's the great new Goodyear Variable Speed Belt—developed through years of research and testing.

And it brings you all the Goodyear *extra-quality* features that assure the maximum, trouble-free horsepower hours at minimum cost. For more details, contact the G.T.M. —Goodyear Technical Man—through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

VARIABLE SPEED BELTS by **GOODYEAR**

THE GREATEST NAME IN RUBBER

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November 14, 1957 Volume 29—No. 23

THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

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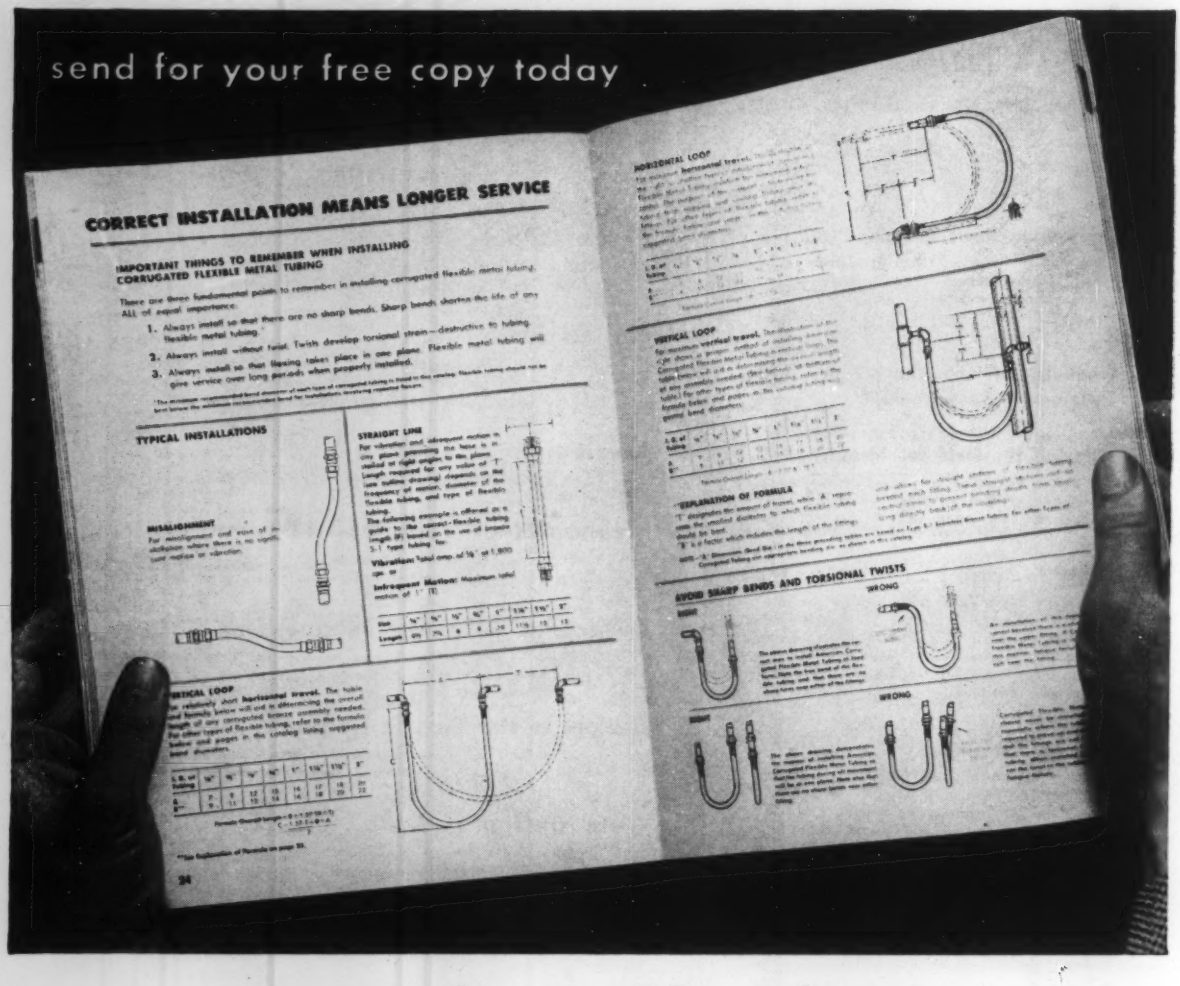

New catalog simplifies selection and ordering of flexible metal hose and tubing

Here's the most complete, most up-to-date catalog on flexible metal hose available today.

Full description of the two basic types of flexible metal hose: corrugated metal tubing and strip-wound hose. Suggestions on correct installation of flexible metal connectors — specifications, bend diameters, length of tubing needed. Type designations and descriptions of flexible hose and tubing made of brass, bronze, aluminum, stainless steel, steel, Monel. Descriptions of end fittings.

Guide to special flexible metal hoses for special jobs: Vibration Eliminators; Flexpipe* flexible connectors; Presstite† connectors for laundry and garment pressing machines; Bracketubes for steam-heated platen presses; Sealtite* flexible, liquid-tight electrical conduit; tank car unloading hose assemblies; tar and asphalt hose assemblies; insulated hose; exhaust and air intake hoses; flexible lamp arms; shielding conduit; Flexlube* oil feed and coolant lines; and other products for special services.

*Trademark †Reg. U.S. Pat. Off. 56185

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flexible metal hose and tubing

AN **ANACONDA**® PRODUCT

MAIL COUPON TODAY FOR YOUR FREE FLEXIBLE METAL HOSE AND TUBING CATALOG!

The American Brass Company
American Metal Hose Division
Waterbury 20, Conn.

Gentlemen: Please send me a free copy of your new flexible metal hose and tubing catalog, G-560.

NAME & TITLE .....
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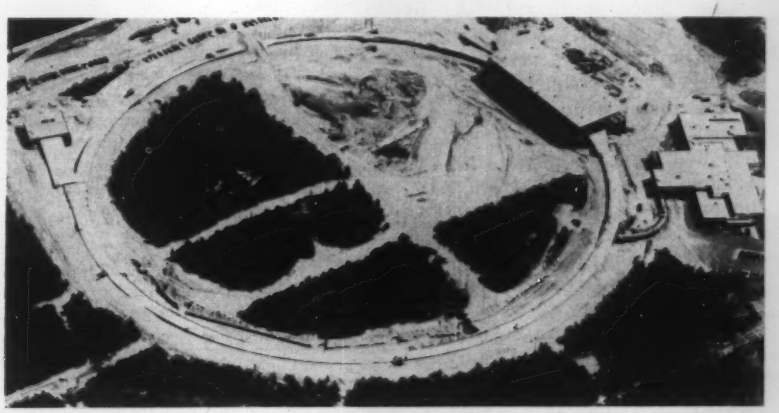
Engineering News Roundup

OFF THE SHELF and in the air in 241 days is an industry record held by Lockheed's Jetstar transport. Designed to meet Air Force requirements for a small utility aircraft, the 10-passenger, swept-wing Jetstar is also eligible for CAA certification. Engine pods attached to rear of fuselage are an unusual design feature which facilitates maintenance and reduces cabin noise. Two Bristol Orpheus engines deliver 10,000 lb of take-off thrust, provide a cruising speed of more than 500 mph at 40,000 ft. A later prototype will use four General Electric J-85 or Fairchild J-83 engines.



TOO LARGE for a building, the 25 to 30-billion electron volt synchrotron will be housed in underground tunnel, ½ mi. in circumference. Atom smasher, being built at AEC's Brookhaven National Laboratory, is scheduled for completion in 1960, will have three times the energy of Russia's 10-bev machine. Eddystone Div. of Baldwin-Lima-Hamilton Corp. will construct 246 magnets, 12½ to 15 tons each. Magnets will enclose ring-shaped vacuum chamber in which protons will be accelerated to 185,000 mps—nearly the speed of light. Orbit of beam will be controlled by new electromagnet principle. Synchrotron will be used for research of subatomic particles.

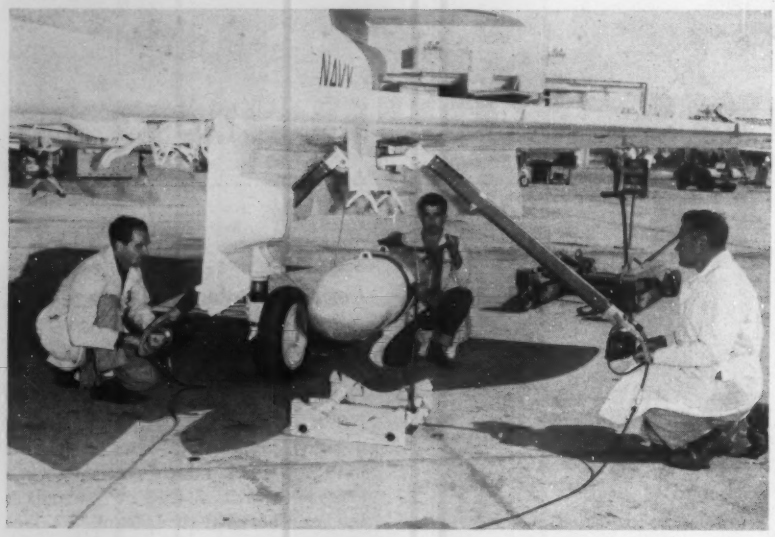
Speakers Stress Simplified Design of Defense Weapons

Trends to Complex Systems Costly, Sacrifice Reliability

NEW YORK—The virtues of simple design; reliability, low cost, and minimum maintenance, were stressed on two recent occasions by members of the Dept. of Defense. Speaking before the Maintenance Advisory Committee of the National Security Industrial Association, Dr. D. P. Barnard discussed budgets and future requirements for funds.

To hold the line on "steadily increasing requirements for money, men, and materials," he advocated improved reliability of equipment to require fewer repairs and overhauls, and therefore, reduced stocks of spare parts. "The finest and potentially most effective weapons decrease rapidly in their value when the demand for maintenance skills exceeds our personnel capabilities; when test equipments required are virtually laboratory items; and when accessibility of a vital adjustment becomes a Herculean task . . . We mean also a forthright effort in the simplification of our new equipment. This is an effort which all too often eludes a designer as he becomes engrossed in the solution to an admittedly complex problem."

He encouraged the increased use of modular type construction, greater use of standard components, and the use of relatively inexpensive "throwaway" elements. Discussing complexity, he said that it has been necessary "for the kinds of weapons we need in our modern military establishment. Unfortunately, the cost of it represents a significant part of the more than 20 million dollars a day we spend to maintain our weapons



PORTABLE BOMB HOIST developed for the Navy by Douglas Aircraft Co. weighs 47 lb; will lift 2500 lb. Hoists can be used in pairs, as shown here, to handle 5000-lb loads. Mechanism includes geared cable drum driven by small electric motor, and telescoping extension tube to permit maximum lifting height of 13 ft. Hand crank is provided for manual operation where power is unavailable. Safety features include overload clutch, shear pin to protect gear mechanism, and load brake that holds load if motor or power fails. An over-running clutch prevents drum rotation when reel-out is attemped with no load on the cable.

and equipment."

Vice Adm. John H. Sides, speaking to members of the American Rocket Society and Institute of Aeronautical Sciences, discussed aspects of the national guided missile program: "Once a missile system has been designed so that it possesses the capability to do the required job, then the one outstanding characteristic which it must have is reliability; and perhaps the next most important attribute is maintainability."

Reliability, he said, is not the result of accident. Original design should not require any component to operate near the limit of its capabilities. Production engineering and fabrication must be insured through careful quality control. Reliability requires continuous and rapid feedback of every discrepancy, whether found through factory inspection, in the field, or in actual service. It has become very apparent that those companies in which top management have the fullest understanding of the need for reliability have had greatest success in that regard.

Adm. Sides continued, "As to maintainability, it is, of course, axiomatic that the greater the reliability of a system, the less will be the maintenance burden. But beyond this the design should be such and the packaging arranged in such a manner that defective components can be identified quickly and easily with proper test equipment, and that these components can be readily replaced. Except in the very small missiles, the idea of returning entire missiles for factory rework is untenable from the operation point of view."

There has always been the fond hope that sooner or later "we might learn enough to start simplifying what goes into the end product. The trend has been and continues to be in the opposite direction. If we get much more clever we shall design ourselves right out of business. . ."

Topics

Five million toothpicks an hour are whittled by a busy machine developed by Reidar Olsen of Merrill, Wis. Even though his machine can produce one toothpick for every person in the U. S. in four 8-hour days, Mr. Olsen does not believe he will put himself out of business. The "traditional" toothpick market, he explains, has expanded because of the cocktail-party-inspired serving technique of impaling shrimp, cubes of cheese, and similar goodies on the little spears.

• • •

Jet engines are being adapted for electric power generation. According to Westinghouse, jet engines will be "prime movers" of industry, as well as a means to change energy from nuclear reactors to usable electric energy.

• • •

Electronic brains are inferior to human brains—at least for translating a foreign language such as Russian—according to a report given at a recent AIEE meeting. The human brain is estimated to have a total storage capacity of 10^{15} to 10^{20} bits; the largest computer stores only about 10^{9} bits—not over one-millionth as much as the human brain. This limitation puts the computer in the first-semester, word-for-word translator class.

• • •

Top secret diet is consumed by a new machine designed to dispose of secret documents quickly and neatly. The machine, made by Meili and Worthington Inc., mixes paper and cardboard with water and grinds everything to a pulp. In this sturdy grinder, even staples do not upset the mechanical digestive process.

Front Cover

Although a pin fastener is not customarily found in two different places at the same time, artist George Farnsworth has imagineered the "double exposure" on this issue's cover to illustrate the versatility of these simple fastening devices. For a more complete treatment of this subject, see Leo Spector's article beginning on Page 122.

. . . Fluid Power news

REPORT No. 11,101

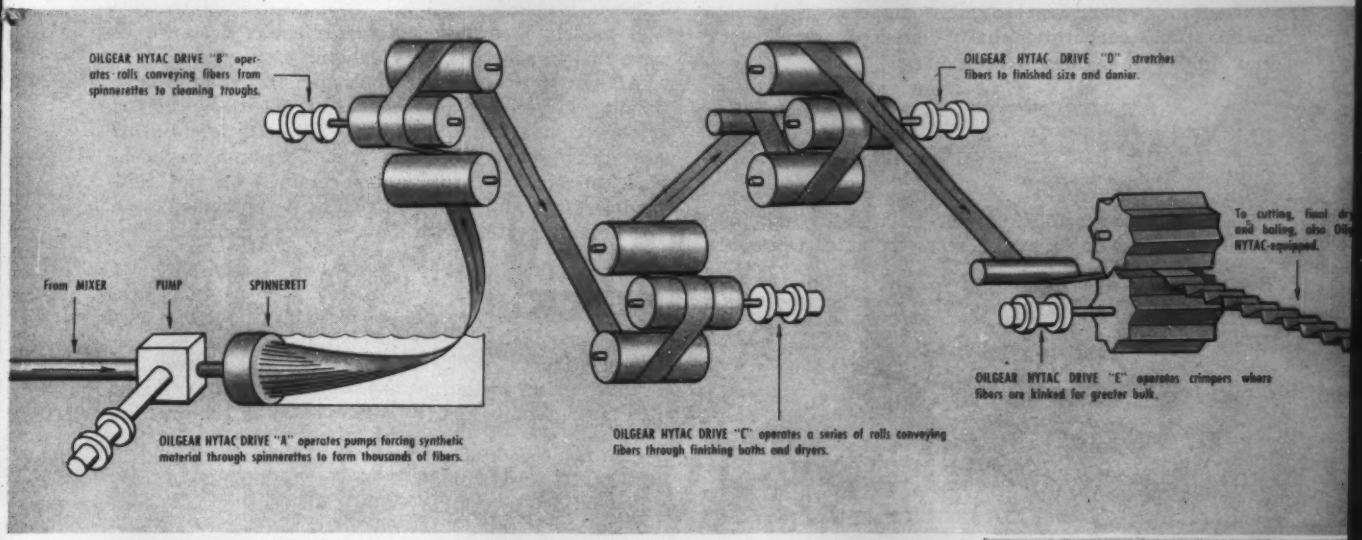
"HYTACS" SOLVE DRIVE PROBLEMS

From Oilgear Application-Engineering Files

HOW OILGEAR "HYTAC" DRIVES SYNCHRONIZE PROCESSING OF NEW SYNTHETIC FIBERS

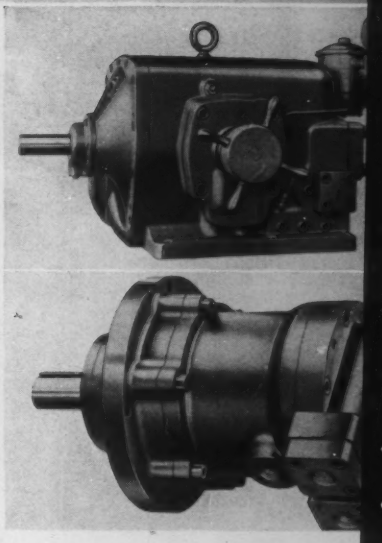
CUSTOMER: *A Producer of Synthetic Fiber (name withheld)*

DATA: Rotary machine drives for complete processing of a new synthetic fiber. User wishes to eliminate line shaft drive, and mechanical, variable speed drive components used in pilot plant due to limited, inaccurate speeds, slow speed changes, difficulty of synchronization. REQUIREMENTS: higher speeds and greater speed range; rapid speed changes; smooth, positive, accurate speed control and synchronization regardless of load variation down to ½ rpm; serviceable by non-technical personnel; safe for use in hazardous atmospheres; occupy minimum space; individual drive flexibility—for addition, removal, or separate operation; keep electrical power requirements to a minimum.


OILGEAR HYTAC DRIVE "B" operates rolls conveying fibers from spinnerettes to cleaning troughs.
OILGEAR HYTAC DRIVE "D" stretches fibers to finished size and denier.
From MIXER
PUMP
SPINNERETT
OILGEAR HYTAC DRIVE "A" operates pumps forcing synthetic material through spinnerettes to form thousands of fibers.
OILGEAR HYTAC DRIVE "C" operates a series of rolls conveying fibers through finishing baths and dryers.
OILGEAR HYTAC DRIVE "E" operates crimpers where fibers are kinked for greater bulk.

SOLUTION: Oilgear "HYTAC" (hydraulic tachometer) "ANY-SPEED" drives are shown above as A, B, C, D, E, for each machine. After completion of the first installation by Oilgear personnel, user plant personnel installed, started, and adjusted the drives on the balance of the machines. Drives operate at different speeds during fiber processing, yet hold a pre-selected speed within ±0.5% regardless of load variation. Drive "D" is most critical, as any speed variation here results in changes in fiber diameter, wrong denier, and breakage. These Oilgear systems are completely sealed, flood-lubricated, and can be remotely controlled. USER REPORTS—dependable, continuous, full-load operation for weeks within pre-selected speed control limits; more than adequate speed and speed range with instant speed changes when required; no lag when starting several sections; electrical power consumption far below initial estimates; little reported maintenance in several years of continuous operation. Due to this outstanding performance record, this plant is 100% Oilgear-equipped—hundreds of Oilgear drive components are used.

For similar practical solutions to YOUR *linear or rotary drive problems, call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to . . .*



Oilgear type "DR-2011" variable delivery (input drive) pump with hydraulic control supplies power to . . .

. . . an Oilgear type "H-2011" constant displacement (output drive) motors. Oilgear "HYTAC" precision, "Any-Speed" drives are available in 1 to 100 hp sizes.

Synchronization of multiple, tandem operations; combining separate operations to handle webs soft and fragile at one point—strong at another; or continuous webs where tension affects quality . . . all need more than conventional drives and controls . . . .
. . . they need Oilgear "HYTAC" precision, "Any-Speed" drives and controls.

THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

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Please direct inquiries to advertiser, mentioning MACHINE DESIGN

Rounding Up the 1958 Automobiles—2

MORE models with more equipment are characteristic of the six automobiles appearing in this issue. With one exception, all lines have added at least one new model for 1958.

New equipment includes self-adjusting brakes, power lubrication, an automatic speed-control regulator, and a portable radio that disengages from the instrument panel. Air suspension and power-dividing differentials are fairly common.

Greater displacement, higher compression ratios, and multiple carburetion have increased horsepower in a number of engines. Top is 400.

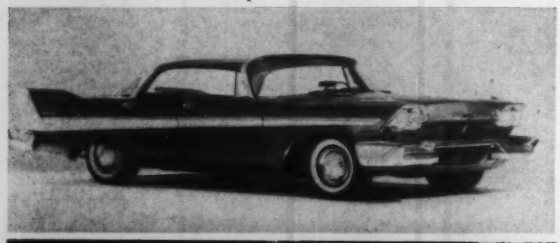
PLYMOUTH

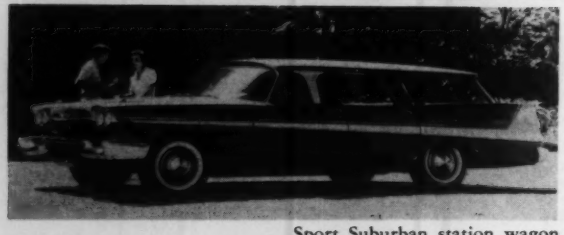
Plymouth offers a choice of 19 V-8 and 17 six-cylinder models for 1958, including six station wagons with either V-8 or six-cylinder powerplants. Optional with four-door station wagons is a rear-facing third seat which folds into the floor for added cargo space. All Plymouth two-door models have 1/3-2/3 divided front seat. Dual headlights are standard.

A new engine line-up for 1958 offers six power options, including the new 350 cu-in. Golden Commando rated at 305 hp. With optional fuel injection, output of the engine is boosted to 315 hp. Standard V-8 for the line, which was last year's top engine, displaces 318 cu in.; rates 225 hp. Standard equipment on V-8 models is a new automatic choke designed to save fuel in short-trip city driving.

All power equipment is optional, including a new, smaller power-steering unit located entirely in the engine compartment. Power-dividing differential is also an option on all V-8 models. Torsion-bar suspension, introduced last year is retained on the 1958 models. Optional air conditioning is combined with the heating system with a single set of controls.

Belvedere four-door hardtop





Sport Suburban station wagon

Engine Specifications

	Powerflow 6	Fury V-800	Golden Commando
Type	In-line, 6-cyl	OHV, V-8	OHV, V-8
Bore & stroke	3.25 x 4.63	3.91 x 3.31	4.06 x 3.38
Displ. (cu in.)	230	318	350
Comp. ratio	8 to 1	9 to 1	10 to 1
Bhp, max	132 @ 3600	225 @ 4400	305 @ 5000
		290 @ 5200*	315 @ 5000†
Torque, max (lb-ft)	205 @ 1200	330 @ 2800	370 @ 3600

*Optional 8-barrel carburetor; special camshaft and distributor.
†Optional fuel injection.

Size and Weight

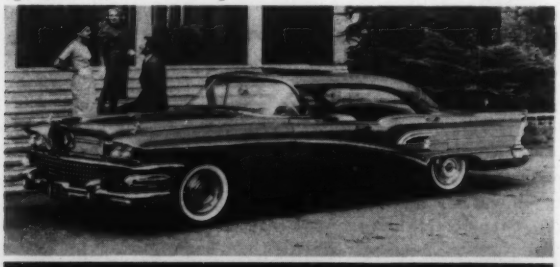
Wheelbase (in.)	118
Length (in.)	204.6
Width (in.)	78.2
Height (in.)	54*
Weight (lb)	3780

*Two-door hardtops.

BUICK

Considerably restyled, Buick for 1958 is available in five series, including 20 body styles. Topping the line is the Limited series, a new entry in the prestige car market. The new edition is 8 in. longer than the Roadmaster and is available in both two and four-door hardtops and convertible models.

Special four-door hardtop



Century convertible

Dual headlights, lower fenders, higher hood, and new grille distinguished by rows of small chrome squares are major front-styling changes.

Heading the list of engineering changes is a new

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Watch BOUND BROOK ADS for SMASHING NEWS in 1958 -- our 75TH year

BOUND BROOK OIL-LESS BEARING CO.
ESTABLISHED 1883 BOUND BROOK, NEW JERSEY

Pioneer in POWDER METALLURGY BEARINGS & PARTS

Dynaflow transmission which uses three turbines, instead of two, to increase torque output. Variable pitch stator vanes tailor transmission performance to engine requirements.

Increased safety is provided by larger braking area

Engine Specifications

	Special	Century, Super, Roadmaster, Limited
Type	OHV, V-8	OHV, V-8
Bore & stroke (in.)	4.12 x 3.4	4.12 x 3.4
Displ. (cu in.)	365	365
Comp. ratio	9.5 to 1	10 to 1
Bhp, max	250 @ 4400	300 @ 4600
Torque, max (lb-ft)	380 @ 2400	400 @ 3200

Size and Weight

	Special, Century	Super, Roadmaster	Limited
Wheelbase (in.)	122	127.5	127.5
Length (in.)	211.8	219.1	227.1
Width (in.)	78.1	79.8	79.8
Height (in.)	57.6	59.4	59.6
Weight (lb)	4150*	4500*	4580

*Approximate.

on all series. Air-cooled aluminum front brake drums with a radial fin design are standard on all models except the Special.

A new optionally available air-suspension system is introduced this year. An added feature of Buick's system is a built-in "lift," actuated by a lever on the instrument panel, which will raise the car 5½ in. above normal ground clearance. The device is provided for use in changing tires or getting out of deep mud or snow.

All models are powered by a 364 cu-in. V-8 engine with two-barrel carburetor on the Special and four-barrel on all other models.

CADILLAC

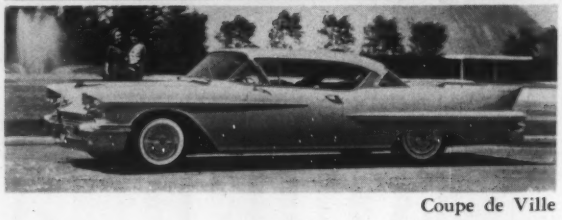
The 1958 Cadillac is available in three standard series featuring 11 body styles, and one custom series, Eldorado Brougham, with one body style. One new model, the Series 62 extended-deck sedan, is added to the 1958 line. The body is the same as the Sedan de Ville with differences being in interior trims and standard equipment. Overall length of all models is increased 0.9 in. with no change in wheelbase.

Front styling has been somewhat modified. Dual headlights are standard, fenders are wider and the hood is longer. Rear profile has been changed with the addition of a newly styled tail fin which appears on all models except the Eldorado Biarritz and Seville.

Interior features include a choice of 55 trim combinations. Printed circuits are utilized for the first time for wiring certain components in the instrument panel. As an option, trunk operation—opening, closing, and locking—can be controlled from the glove compartment.

Four-link rear suspension, pioneered on the Eldorado Brougham, is standard on all 1958 models. Coil springs have been added to rear wheels in the process.

Fleetwood 60 Special Sedan



Coupe de Ville

Engine Specifications

Type	OHV, V-8
Bore & stroke (in.)	4.00 x 3.62
Displ. (cu in.)	365
Comp. ratio	10.25 to 1
Bhp, max	310 @ 4800*
Torque, max (lb-ft)	405 @ 3400

*335 @ 4800 with three 2-barrel carburetors.

Size

	Series 62	Series 60	Series 75
Wheelbase (in.)	129.5	133	147.5
Length (in.)	216.8*	225.3	237.1
Width (in.)	80	80	80
Height (in.)	57.7	59.1	61.6

*Four-door sedan.

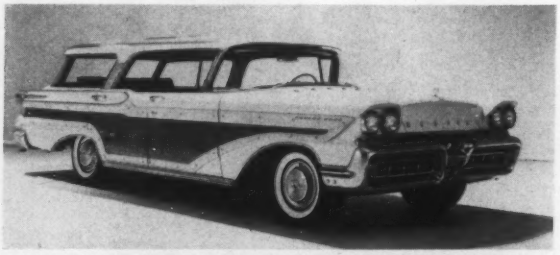
Air suspension is optional on three series; standard on the Brougham.

MERCURY

A new deluxe series and four new engines feature Mercury's line-up for 1958. Twenty models are available including six station wagons.

The new Park Lane series includes three models—

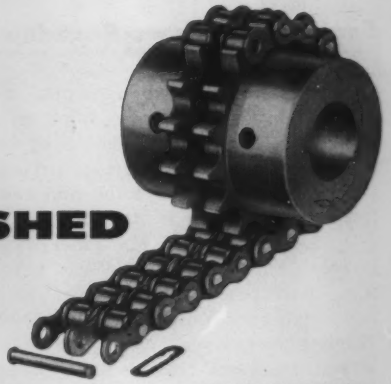
Colony Park station program



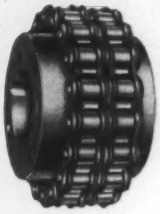
Park Lane Phaeton Sedan

NEW DATA

ON DIAMOND TAPER-BUSHED and FINISHED BORE FLEXIBLE COUPLINGS



STANDARD STOCK DIAMOND COUPLINGS
Double-strand roller chain type. All steel rugged construction. Stock sizes range from fractional to 725 horsepower!



NEW TAPER-BUSHED DIAMOND COUPLINGS
Diamond taper-bushings are stocked in bore diameters varying by 1/16". Bushings are easy to install, fully interchangeable.

DIAMOND CASINGS
Greatly extend coupling life by assuring correct lubrication and sealing out abrasive and corrosive atmospheres.

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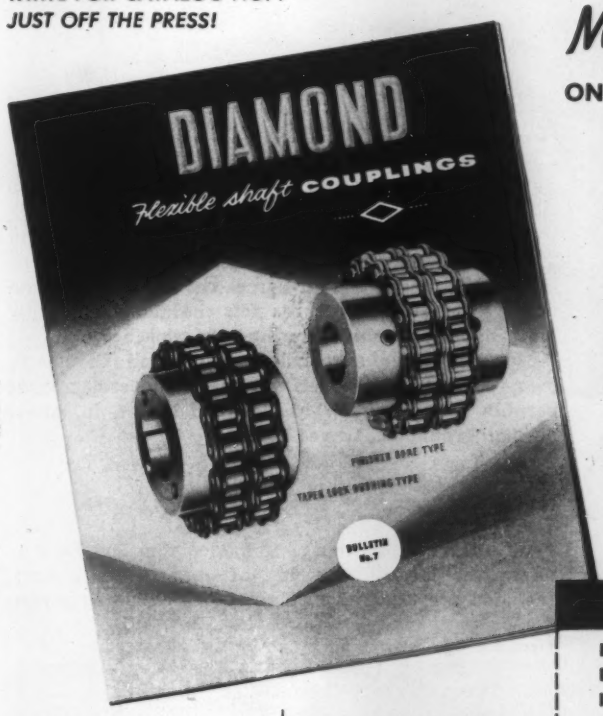

More Useful Information

ON "How to select the right coupling"
"Service factors"
"Horsepower ratings"
"Flexible coupling installations"

This new catalog contains all the information you need to select couplings for any service classification.
Stock Diamond Coupling dimensions, including all stock bores, are charted for quick reference. Diamond Stock Couplings range from fractional to 725 horsepower. Revolutions per minute are charted from 25 through 5000. For sizes smaller or larger than those listed, or for special applications, Diamond engineers will give you recommendations without obligation.

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Offices and Distributors in All Principal Cities

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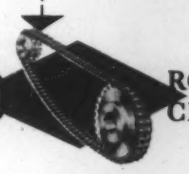

DIAMOND ROLLER CHAINS

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Indianapolis 7, Ind.

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a convertible and two hardtops—and is the largest car in Mercury's history. With an overall length of 220.2 in., it extends 7 in. longer than other cars in the line, and 9 in. longer than last year's editions.

Powering the Park Lane and several of the other top models is one of the biggest engines in motordom. Designated the Marauder 360, it displaces 430 cu in., is rated at 360 hp. With three 2-barrel carburetors, horsepower is increased to an even 400. A new, optional Multi Drive transmission includes a "high performance" range for fast acceleration. All Mercury engines feature water-jacketed intake manifold to stabilize fuel-air intake temperatures, and

Engine Specifications

	Marauder 312, Marauder 330	Marauder 360, Super Marauder
Type	OHV, V-8	OHV, V-8
Bore & Stroke (in.)	4.3 x 3.3	4.3 x 3.7
Displ (cu in.)	383	430
Comp. ratio	10.5 to 1	10.5 to 1
Bhp, max	312 @ 4600 330 @ 4800	360 @ 4600 400 @ 5200*
Torque, max (lb-ft)	405 @ 2900 425 @ 3000	480 @ 3000 480 @ 3200

*Three 2-barrel carburetors.

Size

	Monterey, Montclair	Park Lane	Station Wagons
Wheelbase (in.)	122	125	122
Length (in.)	213.2	220.2	214.2
Width (in.)	81.1	81.1	72.4
Height (in.)	56.5	56.8	58.3

combustion chambers in the block.

Other engineering features include self-adjusting brakes which adjust automatically during reverse braking. Front brakes have been increased ½ in. to 3 in. in width. A new threaded bushing in the front suspension upper arm is lubricated for life with a lithium-based lubricant. Air suspension and all power equipment, including power lubrication, are optional on 1958 models.

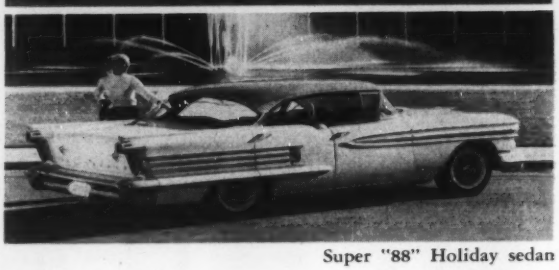
OLDSMOBILE

Oldsmobile offers 16 body styles in three series for 1958. Restyling has resulted in a new recess-type grille, dual headlights, one-piece rear window with greater glass area, and new rear deck and roof. The rear window extends 2½ in. into the roof line. Grille construction is extruded anodized aluminum.

Interior accessories include the Trans-Portable radio that can be removed from the car for use as a portable unit. A speedometer warning device utilizes both a light and buzzer to warn when any preset speed is being exceeded. A new "safety-vee" steering wheel is recessed to the steering column and has rectangular horn buttons located in the spokes, replacing the horn ring.

Oldsmobile is making news for 1958 by reducing horsepower on the "88" series in the interest of fuel economy. Horsepower has been dropped from 277

Series "98" convertible



Super "88" Holiday sedan

Engine Specifications

Type	OHV, V-8
Bore & stroke (in.)	4.00 x 3.69
Displ. (cu in.)	371
Comp. ratio	10 to 1
Bhp, max	265 @ 4400*
Torque, max (lb-ft)	390 @ 2400†

*305 @ 4600 on Super "88" and "98" series.
†410 @ 2800 on Super "88" and "98" series.

Size and Weight

	"88" Series	"98" Series
Wheelbase (in.)	122.5	126.5
Length (in.)	208.2	216.7
Width (in.)	78.5	78.5
Height (in.)	56.9	56.9
Weight (lb)	4260	4480

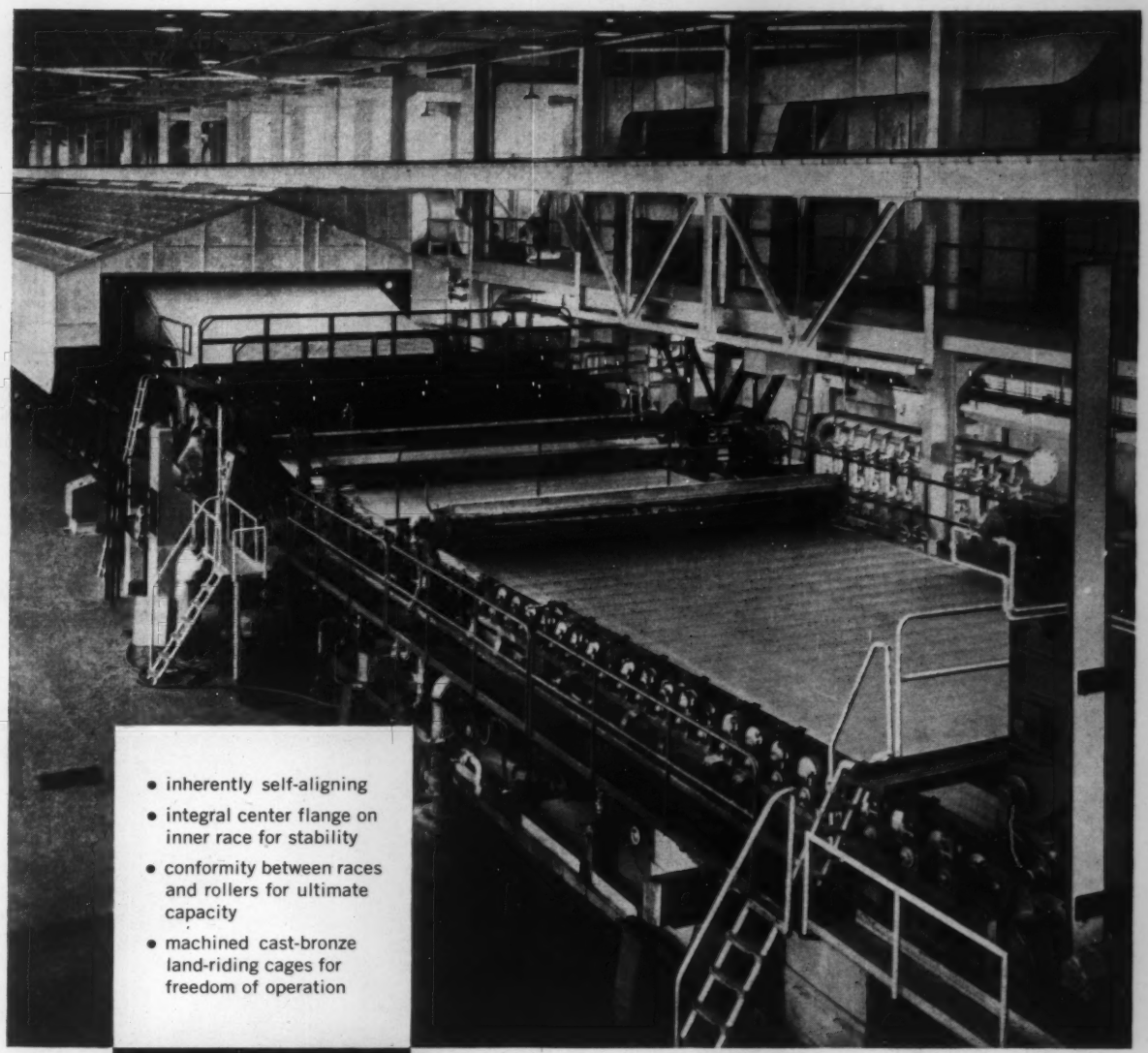
to 265 with the addition of a new dual carburetor. The Super "88" and "98" series retain the 305 hp Rocket engine with four-barrel carburetion. Hydra-matic transmission features new thermostats to eliminate delayed upshifts during cold weather.

New-Matic air suspension, introduced this year, is optional on all models. A manual override valve permits the driver to raise car height 4 in. above normal ground clearance

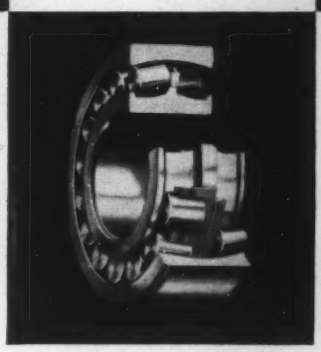
DESOTO

With the introduction of 18 models for 1958, De Soto offers the largest selection of cars in its history. Included are two Adventurer sports cars—a convert-

Firedome four-door sedan



- inherently self-aligning
- integral center flange on inner race for stability
- conformity between races and rollers for ultimate capacity
- machined cast-bronze land-riding cages for freedom of operation



A New World's Record!

World's record on 50# Kraft bag paper—2,200 fpm—is held by this 232-inch paper machine built by Beloit Iron Works for St. Regis Paper Company at Jacksonville, Florida.

Contributing to this performance are 718 Torrington Spherical Roller Bearings on wire rolls, press felt rolls, top press rolls, paper and felt driers and idlers, calenders, suction couch and press rolls, reels and winders. Inherently self-aligning, these bearings compensate for shaft deflection across the machine and eliminate need for periodic realignment.

Torrington Spherical Roller Bearings are available from stock with straight or tapered bores for shaft or adapter mounting. When you are counting on production, count on Torrington Spherical Roller Bearings for smoother, faster, more economical service from wet end to winder. *The Torrington Company*, South Bend 21, Ind.—and Torrington, Conn.

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Fireflite Sportsman

ible and two-door hardtop—to be introduced later in the year.

The hallmark of De Soto styling—high, canted rear fender fins and highly visible three-tiered tailights—has been retained again this year. Exterior finishes number 20 solid colors and 140 two-tone combinations. Safety features include a deep-dish steering wheel and a safety door latch which incorporates a self-tightening rotor with automatic take-up. Padded instrument panels and seat belts are optional on all models.

Two new engines with greater displacement and higher compression ratio have increased horsepower over the entire line. The top engine displaces 361 cu-in., is rated at 305 horsepower with optional four-barrel carburetion. Powerplant for the Adventurer models, with probably a further increase in horsepower, will be announced later.

Three-speed Torqueflite and two speed Powerflite transmissions are again available. Power-dividing differential is optional on all models.

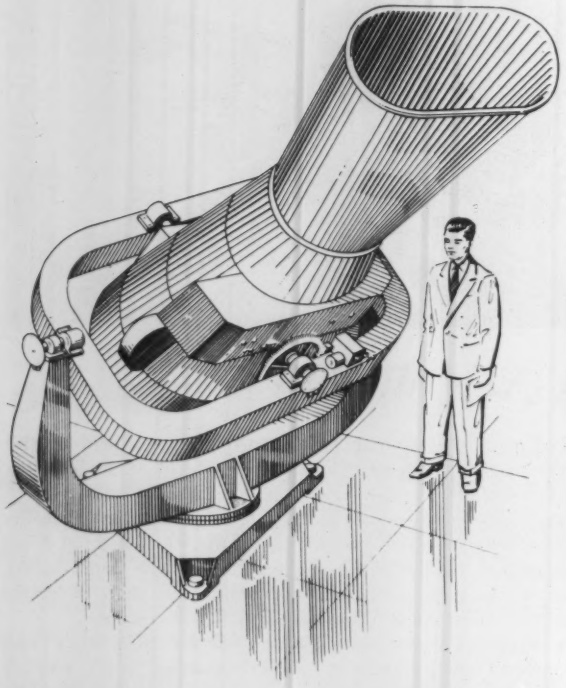
Engine Specifications

	Firesweep	Firedome	Fireflite
Type	OHV, V-8	OHV, V-8	OHV, V-8
Bore & stroke (in.)	4.06 x 3.38	4.12 x 3.38	4.12 x 3.38
Displ. (cu in.)	350	361	361
Comp. ratio	10 to 1	10 to 1	10 to 1
Bhp, max	280 @ 4600*	295 @ 4600	305 @ 4600
Torque, max (lb-ft)	380 @ 2400†	390 @ 2400	400 @ 2800

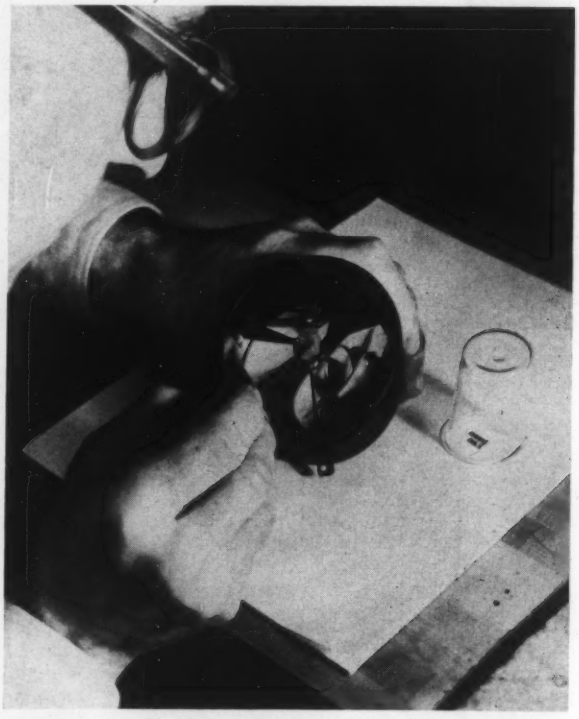
*295 @ 4600 with four-barrel carburetor.
†385 @ 2800 with four-barrel carburetor.

Size and Weight

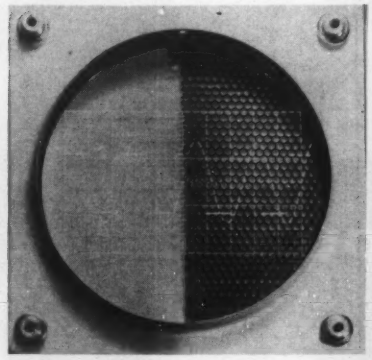
	Firesweep	Firedome, Fireflight
Wheelbase (in.)	122	126
Length (in.)	216.4	218.6
Width (in.)	78.2	78.2
Height (in.)	54.7	55
Weight (lb)	3660	3900



SATELLITE SIGHTER, this tracking camera has 30-deg field of view; optical system designed by Spica Inc., and built by Perkin-Elmer Corp. Twelve of the cameras spaced from pole to pole will help determine, then predict the satellite's orbit. Automatically, camera makes two exposures at once—one of the satellite itself, the other of nearby reference stars.



WEATHER EYE, two of which are to be carried by the earth satellite, will measure radiation emitted from the earth's cloud layer. Pea-size detector in the eye will accumulate infrared radiation, strength of which will be telemetered to earth. Solar battery system will "close" the eye at night. Made by Perkin-Elmer Corp., the eyes will aid long-range weather forecasting.



HONEYCOMB SCREEN substitutes for oscilloscope hood, blocks off reflections that blur cathode ray tube image in bright ambient light. Van Dee Products thin sheet fits directly on scope face, intensifies image, permits full observation of scope face from any point within 45 deg of face-on position.

Girls' Best Friends Now Man-Made

DETROIT—Man-made diamonds for industrial use will soon be available in substantial quantities. More than 100,000 carats of the man-made diamonds have been produced in pilot plant operations at the Metallurgical Dept. of General Electric Co. According to company officials, characteristics of the natural and man-made diamonds are identical. Man-made stones, however, are currently limited to the size of a grain of sand and price is somewhat higher.

The result of a 2½-year, $2½-million dollar project, the industrial diamonds are made in minutes with pressures up to 2,400,000 psi and temperatures up to 5000 F. The diamonds are used in sharpening carbide cutting tools.

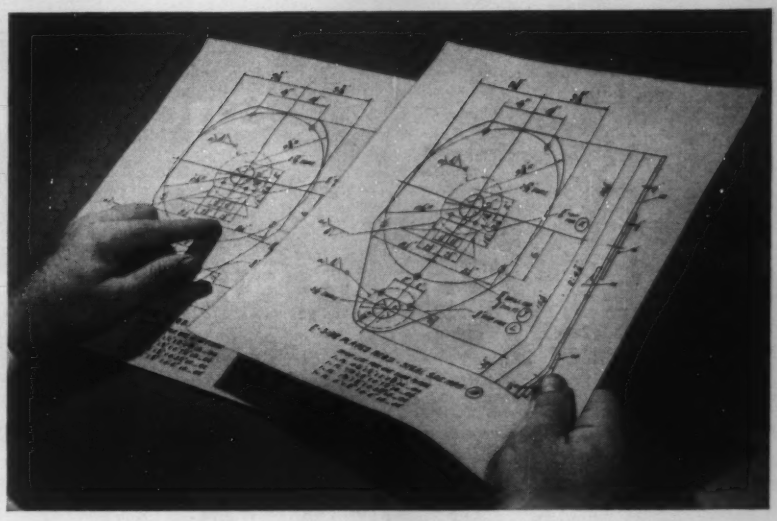
New Standard for Insulation Gives Designer More Freedom

AIEE Revision Recognizes New Concept for Ratings

CHICAGO—Because AIEE Standard No. 1 has been revised, designers will have more freedom in select-

(*Please turn to Page* 22)

DRAFTING TRENDS



Even a printmaking expert cannot look at these two prints and tell which original drawing was made on Phantom Ruled Blutex. Still, there were hours of difference in drafting time required to make the two identical drawings from which these prints came. Write today for a free sample of Phantom Ruled Blutex and see the proof for yourself.

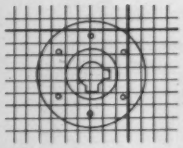
Phantom ruled vellum leaves more time for creative drafting

Working with scaling aids often takes valuable time from the basic job of creative drafting. Add the wasted hours spent drawing guide lines, lettering and handling similar routine drafting problems, and you have the reasons why POST developed Phantom Ruled Blutex.

This new vellum is basically POST's Blutex, unchanged except for the addition of phantom grid lines. The result is a combination of all the time-saving advantages of grid paper with all the drawing and reproduction advantages of famous Blutex vellum.

By using the grid lines, a draftsman works quickly to scale without constantly reaching for scaling instruments. Proportioning and resizing are easier and faster. Freehand drawing truly becomes a rapid, highly creative method of recording ideas. Even lettering and dimensioning are transformed into simpler, less time-killing jobs.

In printmaking, the grid lines disappear completely, leaving a sharp, contrasty print.



More about Blutex

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Due to its carefully selected 100% rag content base, Blutex stands up well under prolonged handling. Even when alterations are done years after an original drawing is completed, Blutex still retains its fine ghost-free erasing qualities and easy erasability.

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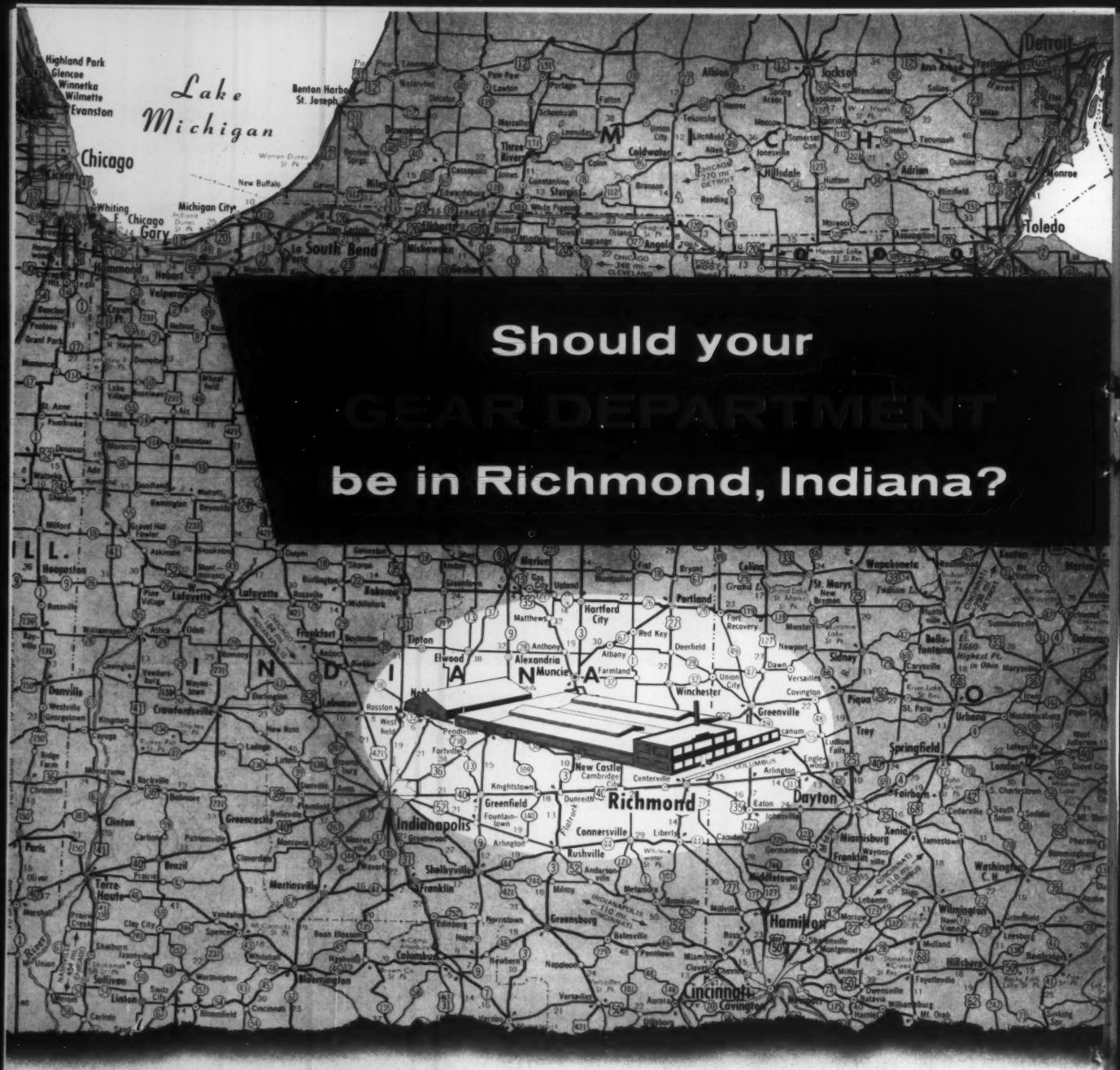

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Reader Information Service

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for More Information . . .

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Increase the availability of your automatic forging equipment ...at no extra cost!

IF you've invested in automatic forging equipment, don't be robbed of your profits by the steel you're forging. Unless it's uniform, you'll be interrupting production to change your setup. These interruptions take time, limit the availability of expensive automatic equipment.

When you use Timken® steel, you get the uniformity you need. Timken fine alloy steel is uniform from bar to bar, heat to heat, order to order. It makes your automatic forging equipment more available—at no extra cost—because you can forge without interruption.

We assure complete uniformity by taking extra quality control steps. For example, we were the first steel manufacturer in the U.S. to use a magnetic stirrer for molten steel. It distributes alloys equally, keeps temperature uniform, and works the slag continuously.

To assure still further uniformity, your order is handled individually. Conditioning procedures are targeted to meet your end use requirement. To limit variations within an order—as well as from order to order—we stamp each bar to identify its heat.

To increase the availability of your automatic forging equipment —at no extra cost—always specify Timken fine alloy steel. You'll get money-saving performance and uniform results every time. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

See the next Timken Televent hour, "The Innocent Years" over NBC-TV, Thursday night, November 21st.

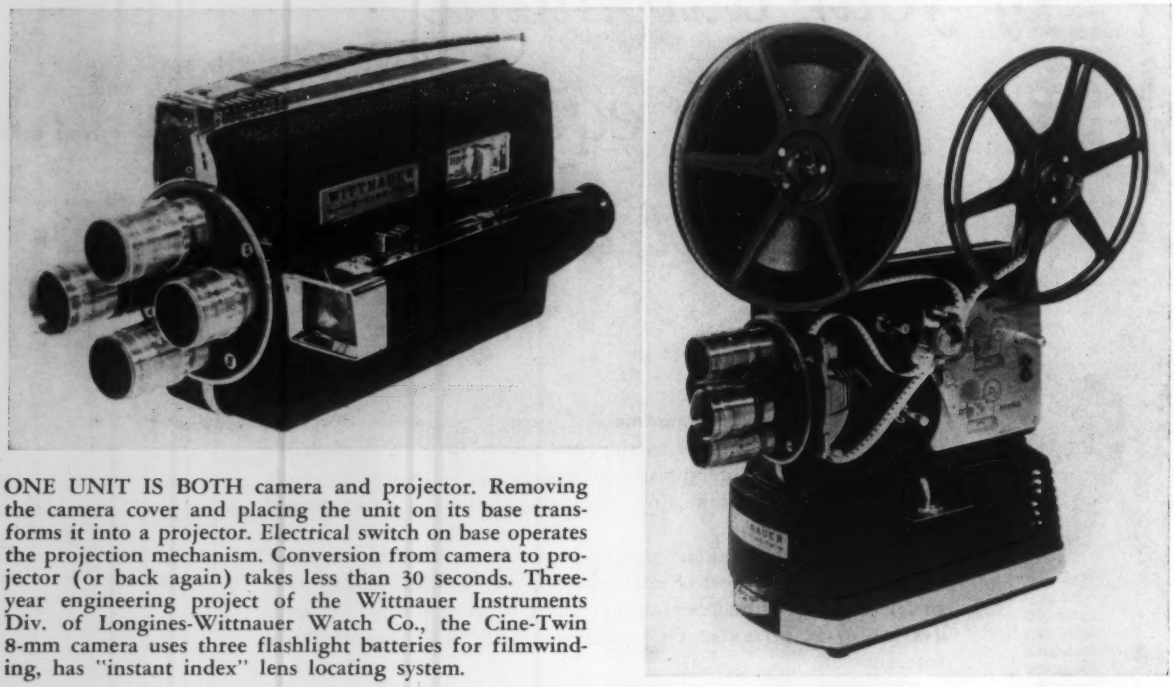
TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

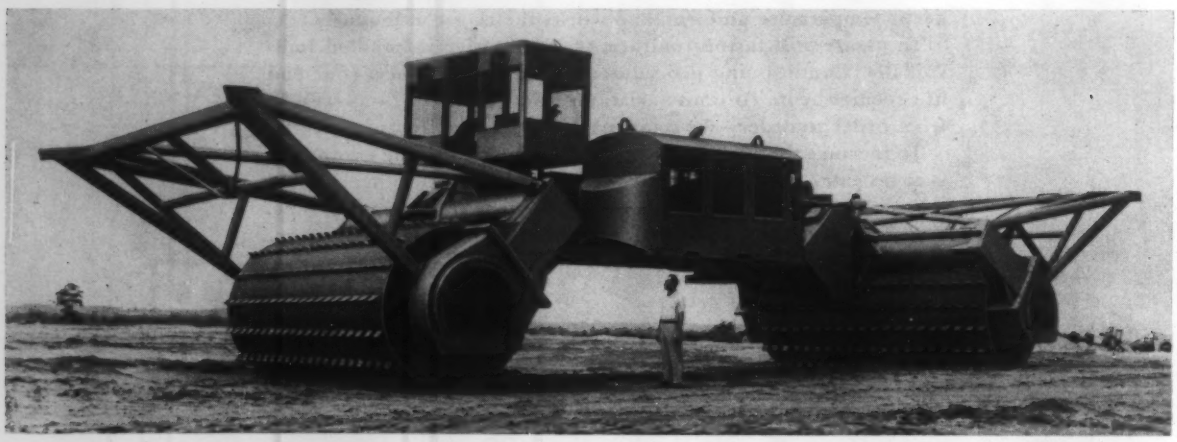
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

(*Continued from Page* 15)
ing insulating materials best suited for their purposes, according to a paper recently presented at an AIEE symposium on insulation. Standards Co-ordinating Committee No. 4, responsible for the revision, pointed out that insulation materials have in the past been grouped solely on the basis of their composition, whether organic or inorganic, but that recent developments make this classification impractical.

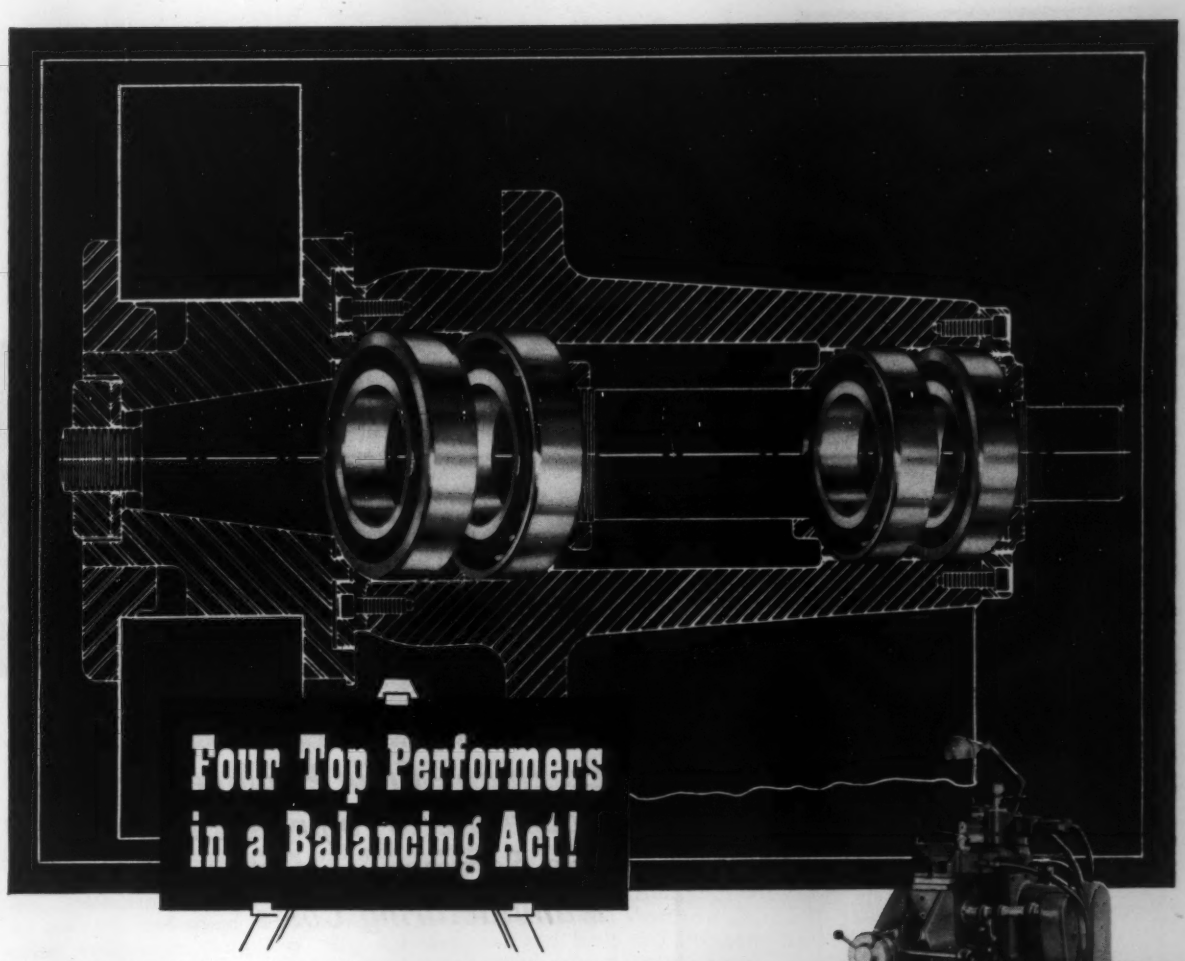
The Committee reported, "Now, it is recognized that the properties of many insulating materials cannot be determined solely on the basis of their composition. . . . With the greatly increased number and variety of insulation materials



ONE UNIT IS BOTH camera and projector. Removing the camera cover and placing the unit on its base transforms it into a projector. Electrical switch on base operates the projection mechanism. Conversion from camera to projector (or back again) takes less than 30 seconds. Three-year engineering project of the Wittnauer Instruments Div. of Longines-Wittnauer Watch Co., the Cine-Twin 8-mm camera uses three flashlight batteries for filmwinding, has "instant index" lens locating system.



ELECTRIC JUNGLE SMASHER crushes full-grown trees and dense underbrush into a mat-like carpet. Cutting a swath 20 ft wide, it will clear an acre of forest in 15 min. Built by R. G. LeTourneau Inc., the 140-ton machine is powered by a 600 hp diesel-electric unit. Gearmotors mounted in both rollers provide direct driving power and control steering. Rollers steer independently or simultaneously. The big machine stands 19 ft high, 76 ft long; is operated with pushbutton controls by one man.



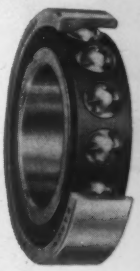
Four Top Performers in a Balancing Act!

To assure true spindle balance, close running accuracy, and vibrationless performance, Royal Master mounts the massive, heat-treated alloy work wheel spindle of its TG-12 centerless grinder on four Fafnir Super Precision Ball Bearings. The spindle assembly itself is mounted directly into the normalized, stress-relieved, close-grained grey iron head stock.

Besides providing proper balance and smooth spindle operation, the Fafnir Preloaded Super Precision Ball Bearings used in the TG-12 eliminate spindle warm-up time—an important feature where the machine is used intermittently. Moreover, relubrication of the bearings is never required. They are lubricated for life when the machine is assembled.

This Royal Master bearing application is a typical example of the Fafnir "attitude and aptitude"—a way of looking at bearing requirements from the designer's point of view and coming up with the right bearing to fit the need. Perhaps the Fafnir approach can be of help to you in finding more economical and satisfactory answers to bearing problems. Write The Fafnir Bearing Company, New Britain, Connecticut.

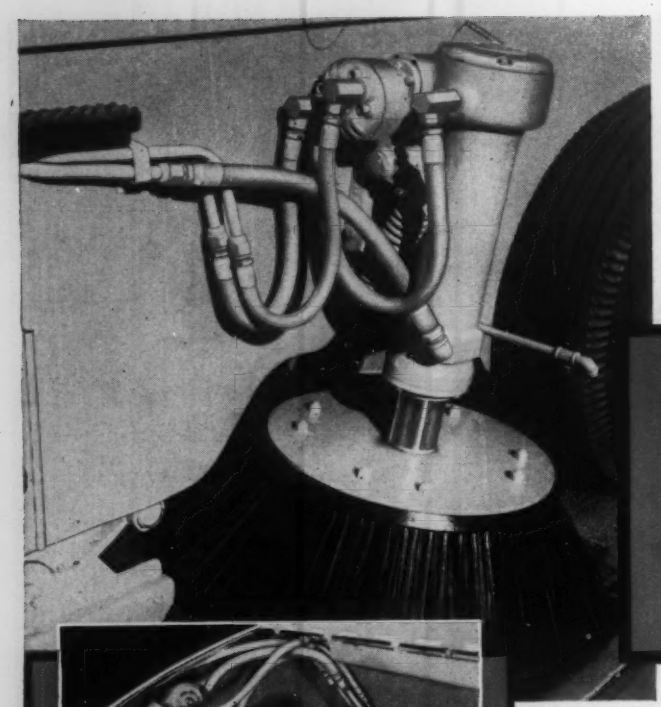
Royal Master TG-12 Centerless Grinder, Fafnir equipped, is designed for thru-feed, plunge feed, and infeed grinding. It has successfully ground materials ranging from plastics to tungsten carbide. Features include accessibility of both sides of wheel from operating position, for high output and fast checking.



◀ Fafnir preloaded, angular-contact, super-precision ball bearings with composition or bronze retainers are made to highest industry-approved tolerances. Single or duplex bearings like this are used widely on spindle applications.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

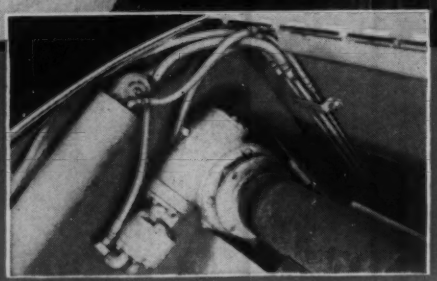
Circle 413 on Page 19



THREE HYDRAULIC CONTROLS INCREASE BROOM LIFE:

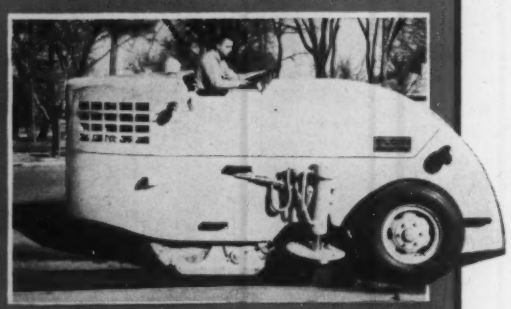
1. Constant sweeping pressure maintained hydraulically with "floating" pressure, which compensates for any street irregularities.
2. Relief valve protects mechanism from curb damage.
3. Snubbing action eliminates bounce and undue wear to the broom.

HYDRAULICS IMPROVE SWEEPER PERFORMANCE



Two hydraulic circuits are used at maximum pressure of 1250 psi., supplied by direct driven pumps independent of vehicle drive.

Conveyor belt is driven hydraulically. Main broom floats under hydraulic pressure, with one lever controlling broom rotation, activating automatic belt training and conveyor belt rotation. Double acting hydraulic cylinders also open and close hopper.



Eastman—Elgin Engineering Staff Cooperate to Improve Efficiency and Service . . . Cut Manufacturing Costs

When Elgin Sweepers were converted to hydraulics, Elgin engineers enlisted the cooperation of Eastman engineers in the pilot application of Eastman Hydraulic Hose Assemblies.

The result of Elgin's conversion to hydraulics was more than an improvement in operating performance and efficiency—it resulted in space-saving economies which permitted dramatic improvements in streamlined design—as well as reduced manufacturing and maintenance costs.

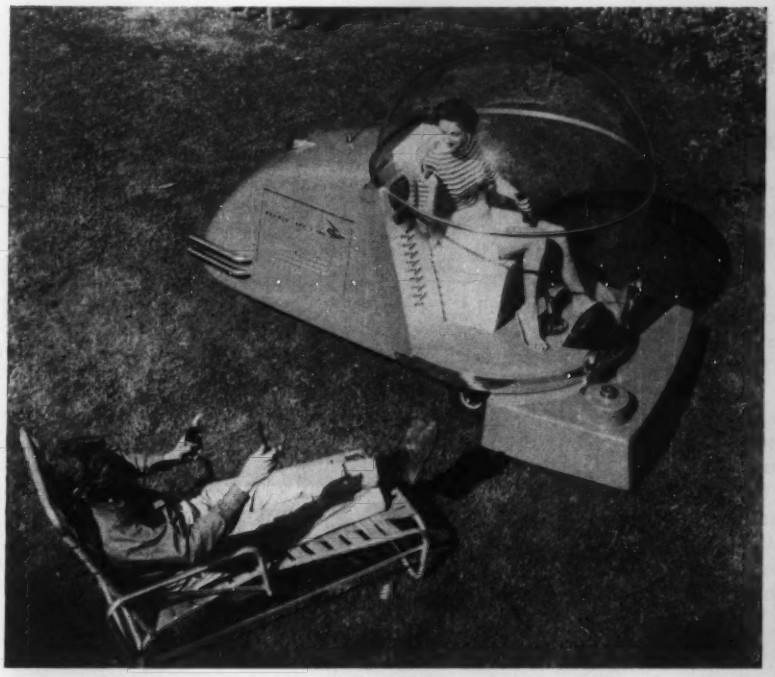
Again, as in many instances in the past . . . Elgin, who pioneered the first successfully marketed sweeper in 1912 . . . turned to Eastman—who pioneered in the very first applications of Hydraulic Hose Assemblies. LEACH PACKMASTER, an associate Elgin product, is also an original Eastman user.

We invite you to write if you have a hydraulic conversion problem. We urge you to call upon our more than 40 years of experience—unequalled in the industry. Take advantage of our many original designs and advanced construction features. Enjoy the sales prestige of Eastman Hydraulic Hose Assemblies—*Standard of the Industry!*

Eastman
first in the field

MANUFACTURING COMPANY
DEPT. MD-11, MANITOWOC, WIS.

Circle 414 on Page 19

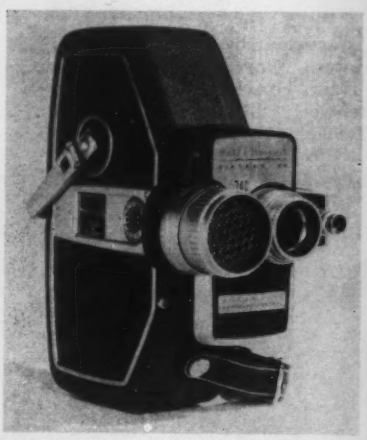


ALL-PURPOSE YARD MECHANIC with sedan styling has a tinted-glass plastic cab for operation in rain or shine. Highly versatile, the three-wheeled machine will mow, feed, and seed the lawn, spray for insects, plow snow, haul equipment, and mulch leaves. In addition, its 12-hp motor provides power takeoff for wood cutting, cement mixing, and winching. Combination joy-stick steering and brake lever simplifies control. With an over-the-road speed of 10 mph, the vehicle doubles as a short-trip, suburban transporter. Simplicity Mfg. Co. designed and built this prototype —unpowered, nonfunctioning—to stimulate interest, gage acceptance.

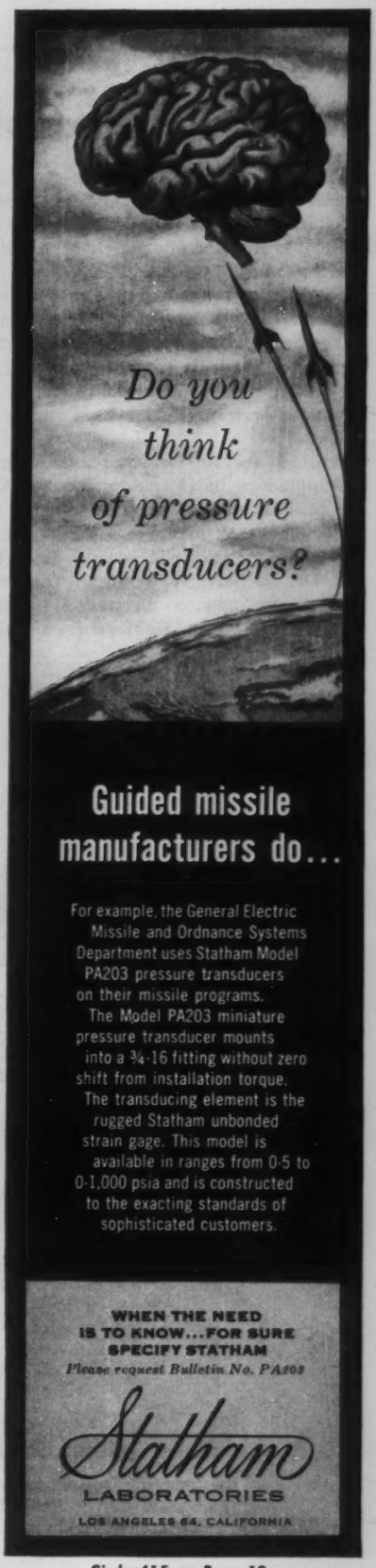
that are available, and in view of the very wide range of their properties, it is necessary to determine the performance of each insulating material and its appropriate temperature limits by actual tests."

The paper recognized that many distinct components in the complete insulation system of a particular equipment may have individual functions to perform, may be subject to different mechanical and electrical stresses, and often to different temperatures.

"Therefore, in the revision of AIEE No. 1," the paper continued, "a clear distinction is made between the temperature classification of insulating materials and the assignment of limiting temperatures for complete insulation systems . . . materials of different temperature classes may be used as components of any particular insulation system."



AUTOMATIC FILM THREADING is added to automatic exposure control in Bell & Howell Model 240EE 16-mm movie camera. To thread the camera, simply slip the film end into the threading mechanism, press the starting button, and the film speeds along its path.


Do you think of pressure transducers?
Guided missile manufacturers do...
For example, the General Electric Missile and Ordnance Systems Department uses Statham Model PA203 pressure transducers on their missile programs.
The Model PA203 miniature pressure transducer mounts into a ¾-16 fitting without zero shift from installation torque.
The transducing element is the rugged Statham unbonded strain gage. This model is available in ranges from 0-5 to 0-1,000 psia and is constructed to the exacting standards of sophisticated customers.
WHEN THE NEED IS TO KNOW... FOR SURE SPECIFY STATHAM
Please request Bulletin No. PA203
Statham
LABORATORIES
LOS ANGELES 64, CALIFORNIA

Circle 415 on Page 19

Mechanisms Conference Draws 285 Engineers

Purdue University was the scene of an impressive gathering of design engineers during the Fourth Mechanisms Conference, October 14 and 15. Co-sponsored by Purdue's School of Mechanical Engineering and MACHINE DESIGN, the Conference has been highly regarded by engineers and designers since its inception several years ago.

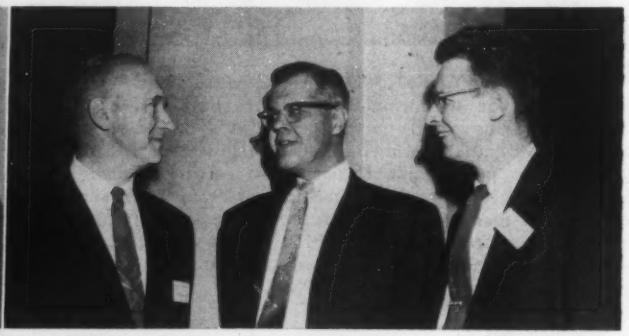
Ten outstanding speakers participated in this year's program. Subjects ranged from practical approaches to design and application of cams and linkages to advanced concepts of analysis and synthesis of mechanisms.

At the opening session, a summary of kinematic developments in Germany and the Continent during the past 10 years was presented by Kurt Hain.

Social events included a banquet on the first evening and luncheon the second day. Banquet speaker was Dr. Richard W. Wallen, prominent psychologist, whose appropriate discussion, "Unlocking Human Creativity," was a Conference highlight.

Speakers at the cam session: Left to right, John A. Carlson, Teletype Corp.; Prof. Harold A. Rothbart, City College of New York; Ray C. Johnson, Eastman Kodak Co.; Leo Spector, *Machine Design,* session chairman; and E. G. Mertz, Eonic Inc.

Linkage design and application were discussed by Prof. Richard S. Hartenberg, Northwestern Univ., member of the planning committee; Kurt Hain, Forschungsanstalt Fur Landwirtschaft, Braunschweig, Germany; and Prof. Thomas Goodman, MIT.



Three key figures at the Conference: Colin Carmichael, editor, *Machine Design,* a member of the planning committee; Dr. Richard W. Wallen, Creelman Associates, banquet speaker; B. L. Hummel, *Machine Design,* Conference co-chairman.

Speakers at the meeting on kinematics: Prof. G. H. Martin, Michigan State Univ.; Prof. Hartenberg; Prof. A. S. Hall Jr., Conference co-chairman, Purdue Univ.; and Prof. C. L. Brown, Purdue Univ.

Pictured after a hard session are W. S. Miller, *Machine Design* (seated); Erwin P. Pollitt, Armour Research Foundation; Ray C. Johnson, Eastman Kodak Co.; and Prof. J. B. Hartman, Lehigh Univ.

In the most forward position

. . . Hannifin valves

Our "NE" valve—one of several Hannifin 4-way directional air control valves. Ask your Hannifin man when to use it.

Persistent research is bringing Hannifin valves to the most forward position in the field of pneumatic controls. These valves are opening up new areas of progress for sequential automatic production.

The Hannifin valves you buy today incorporate the very latest results of never-ending testing and development. Versatility of application and dependability of operation are winning them their position of leadership.

See your Hannifin man. Find out for yourself why Hannifin air control valves are so rapidly becoming first choice for automatic operation.

AIR CONTROL

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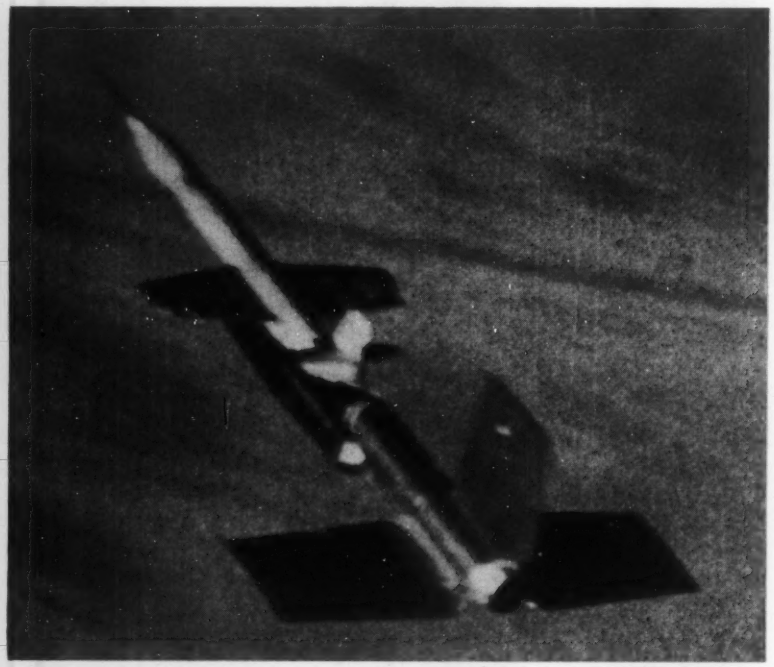
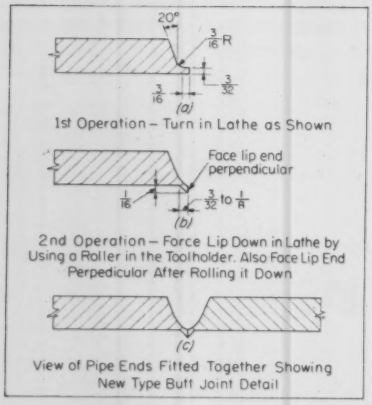
VALVES

For this complete catalog showing all the Hannifin directional air control valves, write to Hannifin Corporation, 515 South Wolf Road, Des Plaines, Illinois.

Circle 416 on Page 19



UPS AND DOWNS are taken in stride by Lockheed's X-7 ramjet missile as it completes its 10th successful flight. Prior to this parachute and nose-spike landing, the elderly missile set three new speed records to become the fastest ramjet missile, fastest ground-controlled missile, and fastest recoverable missile. Performing as a flying laboratory for ramjet engines, the X-7 is launched at high altitude from a B-29. Major maintenance during its long life has been replacement of paint burned off by air friction.


20°
3/16 R
3/16
3/32
(a)
1st Operation – Turn in Lathe as Shown
Face lip end perpendicular
3/16
3/32 to 1/8
(b)
2nd Operation – Force Lip Down in Lathe by Using a Roller in the Toolholder. Also Face Lip End Perpedicular After Rolling it Down
(c)
View of Pipe Ends Fitted Together Showing New Type Butt Joint Detail

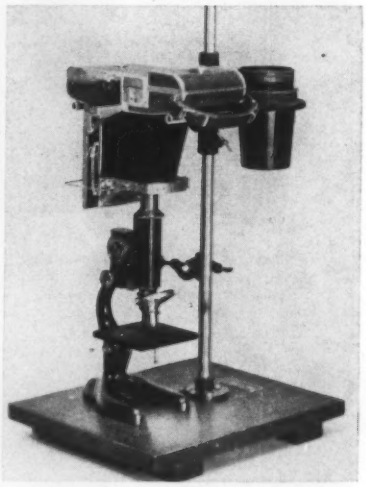
SMOOTH BEAD IN PRESSURE PIPING is welded without need of metallic backing rings or inserts. Trick to technique, developed by Stone & Webster Corp., is bending edge to form circumferential lip and then arc welding.

Slides Made in Two Minutes Used to Record Test Data

New Film Key to Projecting Image Minutes After Exposure

CAMBRIDGE, MASS.—Key to recently announced two-minute slide is a new film, which has a speed of 1000 (ASA equivalent). The panchromatic film produces a virtually grainless slide which permits sharp projection, even as big as 12 x 12 ft. Excellent slides are made by coupling a Polaroid Land Camera to an oscilloscope, microscope, and many other instruments used in science and industry.

For oscilloscopes, record cameras manufactured both by Allen B. Dumont Laboratories and Fairchild Camera and Instrument Corp. make exposures of successive tracings on the same transparency. A greatly enlarged, projected image permits accurate measurements of tracing slopes and time intervals.



In photomicrography, a stand made by Central Scientific Co. holds camera on one arm, focusing

Circle 417 on Page 19→

more motor than ever before

1 TO 50 H. P.

THE REVOLUTIONARY TYPE H

U. S. UNICLOSED

more motor dependability is the result of more and more exclusive features: Asbestos insulation against heat and moisture; Lubriflush bearing construction for longer life; Ventrifoil baffles to direct air, deflect moisture; rugged, normalized cast iron frame . . . all Uniclosed Type H features for longer motor life, more efficient power. Write for profusely illustrated multicolor bulletin today.

U.S. Electrical MOTORS

more LIFE

Lubriflush replaces old grease with new, for longer bearing life. Other life-lengthening features of Uniclosed are explained below.

more RUGGED

Cast-iron frame defies distortion. The smooth cast-iron surface is highly corrosion-resistant. Heavy solid feet are a substantial part of the frame.

more PROTECTION

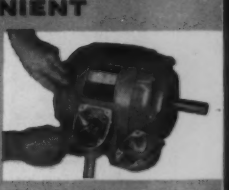
Ventrifoil directs air, deflects water. Each end of motor has specially formed deflector that directs air around bearing housings, into fans on rotor.

more INSULATION

U. S. multiple protection increases insulation life. ASBESTOS — for protection against heat. POLYESTER FILM—for greater physical strength.

more CONVENIENT

The spacious conduit box on Uniclosed Type H is heavy-duty cast-iron, diagonally split type, attractively contoured —easy of access.



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P. O. Box 2058, Los Angeles 54 or Milford, Conn.

☐ *Send Uniclosed Type H Bulletin No. F-1856*

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COMPANY_____

ADDRESS_____

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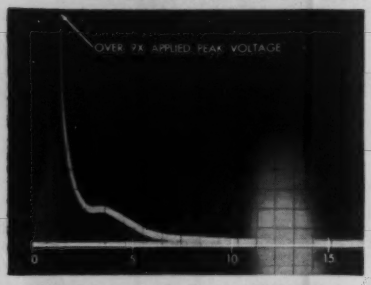
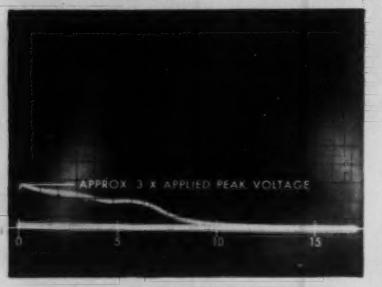
THYRITE® VARISTORS CUT SURGE VOLTAGE



FROM 9 TO 3 TIMES APPLIED PEAK VOLTAGE



ON 115-V CIRCUITS

Sudden interruption in inductive current causes surge overvoltage, arcing, and high-frequency oscillation. Oscillograms (above) show how effectively G-E Thyrite varistors can limit these effects.

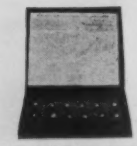
Without a Thyrite varistor (Fig. 1) in the 115-V circuit, surge voltage is 9 times applied peak voltage. With it (Fig. 2), surge voltage is limited to 3 times peak voltage.

With little current drain, they reduce surge voltage and arcing by offering low resistance at peak current . . . discharge circuit energy faster by offering higher resistances instantaneously as current decays.

G-E Thyrite varistors are available for components rated from 6 volts to 4000 volts.

For more information, or Thyrite varistor test kits, write: *Magnetic Materials Section, General Electric Company, 7814 N. Neff Road, Edmore, Michigan.*

THYRITE VARISTOR KITS



Kit No. 1: ½" dia. disks—2 each of 6 ratings (6V to 115V—.1w); color coded with connecting leads. Price: $5.00.

Kit No. 2: ¼" dia. rods—2 each of 5 ratings 115V to 4000V—.25w); color coded with connecting leads. Price: $5.00.

Progress Is Our Most Important Product

GENERAL ELECTRIC

"Thyrite" is a trademark of General Electric Company

Circle 418 on Page 19

SOLDERING ALUMINUM WITHOUT FLUX, accomplished with zinc-base alloy, makes joints stronger than the metal itself. In techniques developed at Bell Telephone Laboratories, a single stroke of the solder stick across the heated aluminum surface causes solder to penetrate the oxide and wet the aluminum. Once wet, surfaces can be joined by bringing them together and adding more solder. Long-term stability of the solder is assured by high purity of the inexpensive alloy. The technique is equally effective for joining galvanized surfaces without a flux.

cone on other. After focusing, camera is swung around to record the magnified subject.

The slide may be projected before a group, diazo-copied as for inclusion in an informal report, or used to illustrate a book or magazine. Image of the slide shows great range of tones since new film reproduces several times the brightness range that is possible in paper prints

Automatic Production Standards Offered Electronics Industries

One Proposes 8-Channel Controls Tape 1 In. Wide

SAN FRANCISCO—Dimensional systems and nomenclature are the subjects of new standards recently proposed for U. S. electronics industries. The standards provide a basic module of 0.025 to which electronic units with printed circuits are already being made.

The standards would serve as guides to co-ordinate the design of equipment, components, and machinery for automatic manufacture. Sponsor of the standards is the Electronic Industries Association (EIA), formerly named Radio - Electronics - Television Manufacturers Association (RETMA).

Another standard developed by EIA, and presently in the approval stage, will be the first industry punched-tape standard. Initially designed for machine tool control, the standard tape is 1 in. wide and accommodates a maximum of eight

HERE'S self-alignment

IN A STEEL HOUSING

HOW "MILL BEARINGS" MAINTAIN ALIGNMENT. Spherical inner ring is free to align in any direction. Full load capacity is assured regardless of shaft deflection or misalignment.

"Mill Bearings" are available for shafts up to 11 inches.

SUPER-RUGGED CAST STEEL HOUSING. Cap is anchored solidly by extra large dowels and four heat-treated thru-bolts with serrated steel nuts.

LINK-BELT "Mill Bearings" with steel housings compensate for inaccuracies of welded and concrete support structures

HERE'S one bearing really built to take the grind and grime of heavy loads in steel mills, mines, foundries and other extra-severe applications. The self-aligning Link-Belt "Mill Bearings" with cast steel housing adjust for misalignment of shafts and support structures. Furthermore, it eliminates the need for extra heavy shafting to avoid deflections which are ruinous to ordinary bearings.

This bearing is effectively sealed, self-contained, factory-adjusted—needs no shims or alignment rings at installation. Get full facts in Book 2565A . . . or Book 2550, which covers industry's most complete line of self-aligning ball and roller bearing blocks. Ask any of the 40 Link-Belt offices.

14,442-A

LINK BELT

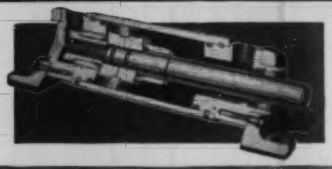
self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

Circle 419 on Page 19

O-M
COMPACT IN DESIGN
KING SIZE
IN PERFORMANCE

O-M Tie-Rodless Cylinder
150 psi Air — up to 1500 psi Oil



Meets JIC Standards
Fits Where Others Won't

Here's the famous O-M Original Tie-Rodless Cylinder that takes one third less installation space than conventional tie-rod type yet packs plenty of power on both air or hydraulic circuits.

The result of modern research, design and engineering know-how, this powerful O-M component figures importantly in today's automation picture. Its high operating efficiency and ease of maintenance combine with its space-saving design and rugged construction to make it highly desirable in any application where its capacity meets specifications. Ports are easily oriented to any position.

O-M Air and Hydraulic Tie-Rodless Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

Mail coupon now for Bulletins 101A (O-M Tie-Rodless Air and Hydraulic Cylinders) and 105 (O-M Series T-H Heavy duty Hydraulic Cylinders).

ORTMAN-MILLER MACHINE CO.
7143rd Street, Hammond, Indiana

☐ Have representative call
☐ Send Bulletins 101A and 105

Name_____ Position_____
Company_____
Address_____
City_____ Zone____ State_____

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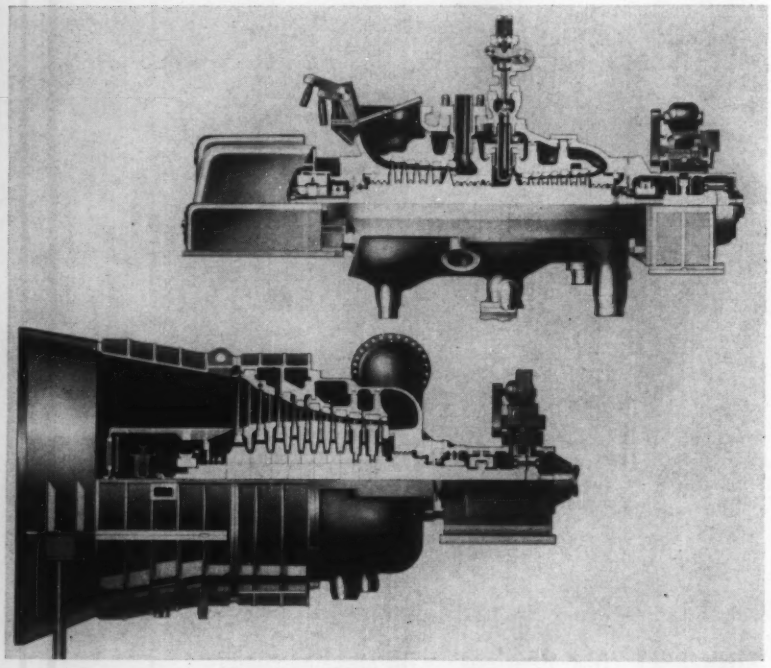
levels or channels.

The standards were described by Cyril P. Atkinson, assistant professor of engineering design, University of California. He spoke at the Eighth National Conference on Standards held in conjunction with the 39th annual meeting of the American Standards Association.

Atkinson observed that several other agencies besides EIA have also been preparing standards for automatic control, computers, data processing, and programming. These are: "Automatic Control Terminology" by the American Society of Mechanical Engineers; "Standards on Electronic Computers" by the Institute of Radio Engineers; and "First Glossary of Programming Terminology" by the Association for Computing Machinery. Sectional Committee C85, operating under the procedures of the American Standards Association is preparing its "Automatic Control Terminology" for approval as an American Standard.



In cross-compound turbine generator, low-pressure element runs at 1800 rpm, high-pressure element at 3600 rpm. View shows "axial flow," low-pressure element (bottom), high-pressure element with reheat section (top).

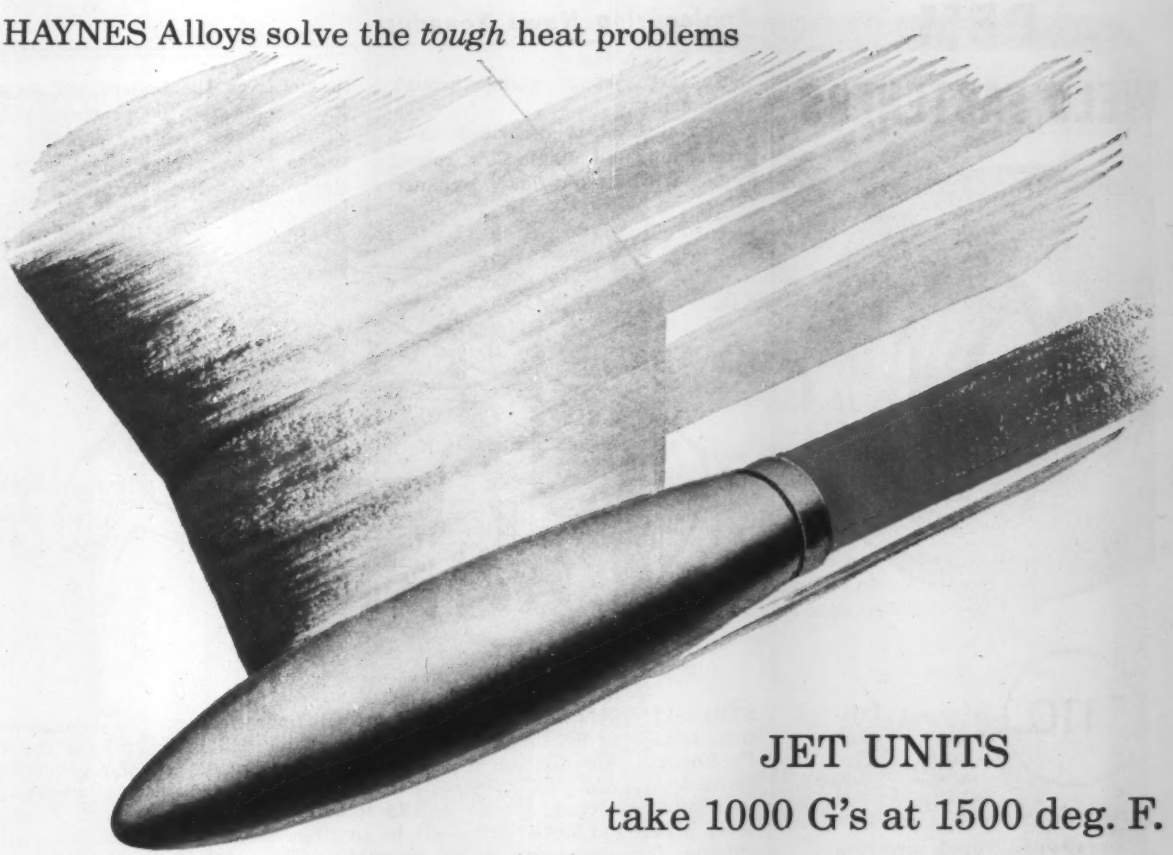
Steam Exhausts Horizontally From Turbine-Generator Unit

Permits Use of Single Level For Turbine and Condenser

SCHENECTADY, N. Y.—In new turbine generator, steam exhausts horizontally along the axis of the turbine shaft into the condenser which is attached to the end of the turbine. New feature in General Electric Co.'s turbine improves efficiency of the turbine and reduces construction costs because condenser, customarily located beneath the turbine, is now located at same level.

Built for the South Carolina Gas & Electric Co., the new unit will be installed in power station on Lake Murray. The cooling water necessary to condense steam from the turbine will come from the depths of Lake Murray above the dam. Temperature of the water is seldom above 55 F, thus makes it possible to obtain maximum

HAYNES Alloys solve the *tough* heat problems



JET UNITS
take 1000 G's at 1500 deg. F.

Mounted to the tips of the rotor blades of a new type aircraft are small pressure jet engines encased in shells of HASTELLOY alloy X. In flight, these jet units are subjected to extremes in stress and heat. HASTELLOY alloy X was selected for the shell material because of its high strength at temperatures in excess of 1500 deg. F. and because it is readily formed and welded.

If you have a high temperature or a difficult design problem, contact our nearest sales office, or write HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana. Sales Offices in Chicago, Cleveland, Detroit, Houston, Los Angeles, New York and San Francisco.

XV-1 Convertiplane in history-making flight ... HASTELLOY alloy X sheet was dished and welded to form the shell of the jet units mounted to the tips of the three rotor blades.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY
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"Haynes," "Hastelloy" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

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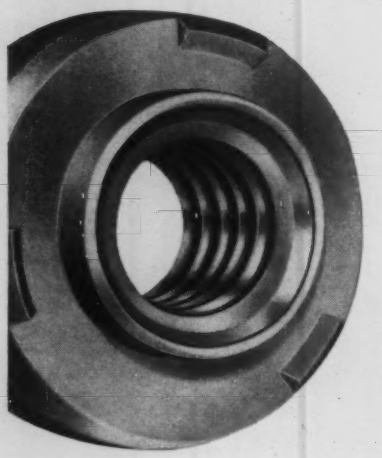
PEM
WELD FASTENERS



no...

- . . **BURNOUTS** in thin sheets.
- . . **RETAPPING.** Shank protects threads from weld splatter.
- . . . **PILOTS** or costly special electrodes.
- . . **INDEXING.** Round compact shape. Self-locating. Fit on narrow flanges.

yes...

PEM WELD FASTENERS

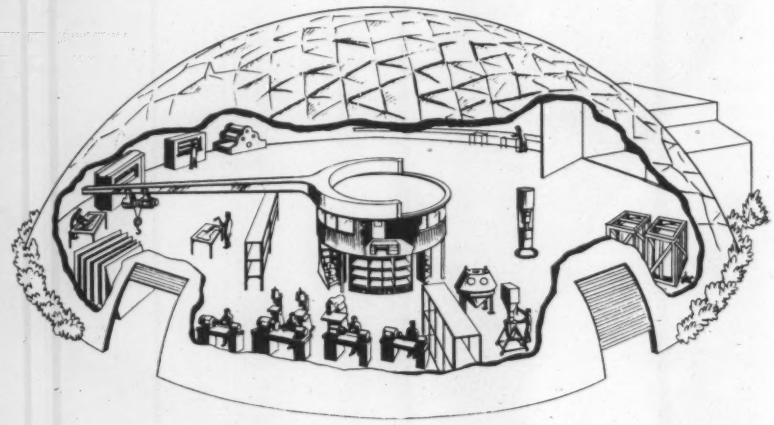
Steel or stainless steel (non-corrosive, non-magnetic) will do a better fastening job at lower cost, wherever load carrying threads are required in thin weldable metals. Write for literature and samples. Penn Engineering & Manufacturing Corp., Doylestown, Pa.

PEM

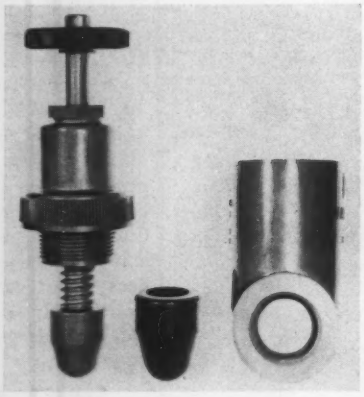
Circle 422 on Page 19

power from steam going through the turbine.

The turbine is described as a cross-compound, single-flow, reheat type with axial-flow exhaust. Steam from the boilers will enter the turbine at 2400 psig and 1050 F. The high-pressure element revolves at 3600 rpm, the low-pressure element at 1800 rpm.



STRESSED-SKIN DOME of aluminum will house factory. The dome structure, reinforced by aluminum panels and struts, will be erected for the Fi Fo Conveyor Co. for use in manufacturing pneumatic granular conveying systems. According to company officials, dome answers need for attractive, economical structure. It will be 145 ft in diam and 49½ ft high. A two-level office and stock room will be in the center of the plant with machining, forming, painting and assembly departments in surrounding segments. Plans call for installation of a single boom, 5-ton crane.



PLASTIC GATE VALVE for conveying abrasive and corrosive liquids is available in several plastic materials. It is claimed to combine the best features of both gate and globe type valves. Closure plug has a resilient cap that is easily removable; can be replaced without removing valve from line. Developed by Vanton Pump & Equip. Co., the new valve is rated at 200 lb working pressure; comes in 1 and 2-in. sizes.

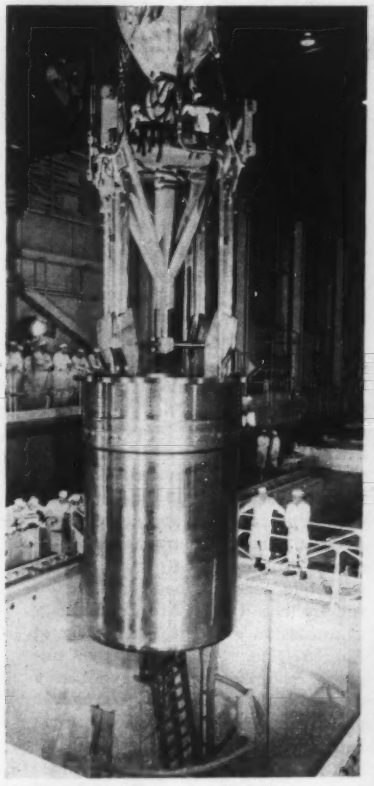
12,000-mph Midget Missile Fired from Research Gun

Not a Weapon, 2-Stage Gun Aids Missile Studies

WASHINGTON — A hypervelocity gun fires midget missiles at 12,000 mph. Developed at the Naval Ordnance Laboratory, the two-stage, gas-fired 40-mm gun is designed to perform basic aeroballistic research on missiles in the laboratory. Not a weapon, the gun is able to fire a special nylon-sphere test projectile at a velocity over 18,000 fps.

Its two firing chambers use a high-pressure hot gas mixture instead of conventional gunpowder. Both chambers contain helium mixed with a volatile combination of hydrogen and oxygen under great pressure.

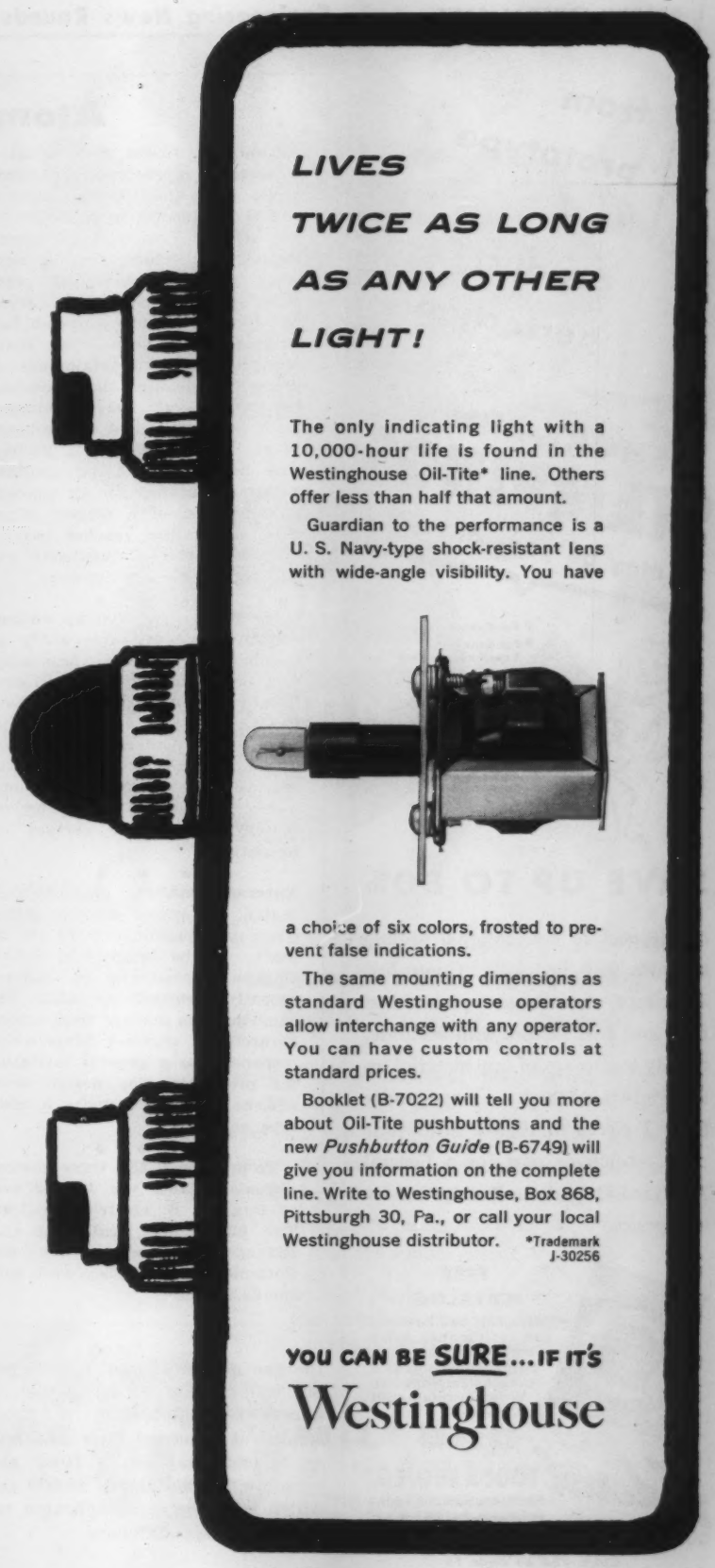
The chambers are aligned, with only a thin steel diaphragm separating them. Another diaphragm



FUEL CHARGE, 58-ton "heart" of atomic reactor, is lowered into its 33-ft high steel container. Tenseness prevailed as atomic power engineers and technician lowered the 6-ft high, 6-ft OD core with only 0.06 in. clearance between walls of the stainless steel container. The core includes 14 tons of natural uranium surrounding 165 lb enriched uranium. The Shippingport plant is a joint project of the Atomic Energy Commission and the Duquesne Light Co. Westinghouse designed and developed the nuclear reactor; also, built the 100,000-kw turbine generator. Extremely pure water, to serve as both moderator and coolant, will flow at the rate of 18,000 gallons per min to produce the 60,000-kw minimum power. The water will be at 2000 psig pressure with average temperature of 525 F.

is placed behind the projectile in the forward end of the front chamber.

As the gun is fired, the front and rear chambers are exploded in sequence by means of a primer. When the front chamber is fired,


LIVES
TWICE AS LONG
AS ANY OTHER
LIGHT!
The only indicating light with a 10,000-hour life is found in the Westinghouse Oil-Tite* line. Others offer less than half that amount.
Guardian to the performance is a U. S. Navy-type shock-resistant lens with wide-angle visibility. You have
a choice of six colors, frosted to prevent false indications.
The same mounting dimensions as standard Westinghouse operators allow interchange with any operator. You can have custom controls at standard prices.
Booklet (B-7022) will tell you more about Oil-Tite pushbuttons and the new Pushbutton Guide (B-6749) will give you information on the complete line. Write to Westinghouse, Box 868, Pittsburgh 30, Pa., or call your local Westinghouse distributor. *Trademark
J-30256
YOU CAN BE SURE...IF IT'S
Westinghouse

Circle 423 on Page 19

FREDDY FEDERAL SAYS:

from prototype to product perfection

SHORT-RUN STAMPINGS may be your answer

- For Cutting Costs
- For Expediting Experimental Work
- For Speeding Pilot Plant Operation
- For Making Quick Product Changes
- For Meeting Time and Cost Budgets
- For Replacement Parts on Obsolete Equipment
- For Small Orders

SAVE UP TO 80%

of the cost of conventional tooling methods with Federal's "Controlled Tolerance" short run stampings. Meet time and cost factors with accurate, quality stampings of any material up to 10"x14"x¼" thick . . . any quantity from 2 pieces to 10,000. Send your print, sketch or part for a Federal Analyzed Quotation. Prompt service and prices.

FREE CATALOG

Tells where and how you can save money using Short Run Stampings. Gives design tips that reduce stamping costs. Write for catalog 201 today.

Federal TOOL & MFG. CO.
3630 Alabama Avenue
Minneapolis 16, Minn.
QUALITY STAMPINGS IN SMALL QUANTITIES

Circle 424 on Page 19

Atom Angles

Advances in fusion were reported at recent conference of representatives from the United Kingdom and U. S. Reports from the meeting held at Princeton University suggest the achievement of neutrons from thermonuclear reactions, but more experimental work will be necessary to establish this as a fact. There are two main requisites for the attainment of power producing thermonuclear reactions. First, heavy hydrogen must be heated to a temperature of at least 100 million C. Second, this hot gas must be confined within a container for an appreciable fraction of a second. When the temperature reaches several million degrees C, neutrons will be emitted in large numbers.

• • •

Locomotive powered by nuclear energy, after intensive study of feasibility, appears promising. Technical staffs of Baldwin-Lima-Hamilton Corp. and the Denver, Rio Grande & Western Railroad, assisted by Walter H. Kidde Associates, and in concurrence with the AEC, have approved a long range program of continuing research to elaborate certain information.

• • •

Natural uranium, graphite-moderated, gas-cooled nuclear power plant of approximately 40 kw capacity will be designed by Kaiser Engineers, according to contract recently awarded by AEC. The company was selected from among 31 architect engineer firms which responded to a general invitation for proposals. The design work will be performed under a cost-type contract.

• • •

To produce U-235, three gaseous diffusion plants use 13 per cent of total U. S. electricity output. The plants are located at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio. They were built for $2.5 billion.

U. S. "Atoms for Peace" program, encouraging nuclear energy for peacetime uses throughout the world, is gaining momentum. In Latin America, first nuclear fission was achieved with recent successful startup of research reactor on campus of the University of Sao Paulo in Brazil. The "swimming pool" type of reactor, built by Babcock & Wilcox, is designed to produce 5000 kw of power. For Japan's Atomic Energy Research Institute in Tokyo, American Machine & Foundry Co. plans to export a tank type, heterogeneous, heavy water cooled and moderated 10,000 thermal kw reactor. To Greece goes a 1000 thermal kw pool type reactor for use by their Atomic Energy Commission. Nuclear Training Center in Puerto Rico has recently been contracted for by the U. S. Atomic Energy Commission and the University of Puerto Rico. Authorized by Congress, the Center will eventually have a 1000-kw pool-type reactor and research center as well as training facilities for agriculture and mechanical arts, also for medical and biological applications of nuclear energy.

• • •

Highest neutron flux of any reactor and largest spaces within an enriched uranium core are design features of new Engineering Test Reactor.

Built at a cost of $14 million, plus $2 million for associated facilities and equipment, it will be used in studying the effects of intense neutron and gamma ray bombardment on component parts of nuclear power plants and propulsion units.

The Atomic Energy Commission considers its new reactor, recently constructed at the National Reactor Testing Station in Idaho, a major development in the national reactor research program.

the gas pressure rises to 8000 psi, but is not quite strong enough to burst the diaphragm. A thousandth of a second later, the rear or second chamber is fired and pressure there rises to 48,000 psi, which ruptures the diaphragm between the two chambers.

Combined action of the two chambers increases pressure to over 60,000 psi. Temperature reaches 10,000 F. Combination of the extreme temperature and pressure bursts the front diaphragm and hurls the projectile from the gun barrel.

Versatile Liquid Adhesive Bonds Metals, Plastics, and Ceramics

One Drop Sticks Steel to Steel With 5000 psi Tensile Strength

NEW YORK — High strength and the ability to join a wide variety of materials are outstanding properties of a new liquid adhesive developed at one of Eastman Kodak's research laboratories.

Bonding with the new cyanoacrylate is accomplished without heat, pressure, evaporation of solvent, or long curing times. It is claimed to work well with metals, glass, wood, ceramics, rubber, cork, felt, porcelain, many types of plastics and a number of other materials. Among the metals tested, combinations of steel, aluminum, copper, magnesium, bronze, and brass were bonded successfully.

The rapidity with which strong bonds are formed depends upon the nature of materials being bonded. Tests have shown glass-to-glass bonds to be unbreakable within 5 to 15 sec. Steel-to-steel bonds set in 15 to 20 sec, develop 2000 psi tensile strength within 30 min and 5000 psi after 48 hr. After a cure of several weeks, the tensile strength increases slightly.

From its evaluations Eastman anticipates industrial applications for the adhesive will develop where extreme speed of setting and curing is needed, where there is a necessity for bonding like or unlike materials not normally responding to conventional adhesives or cements, and where there is a requirement for high bonding strengths within the confines of small joining surfaces such as miniature assemblies of intricate design. Thus, the unique combination of properties of the new product may lend a new approach to the use of adhesives in a number of production fields.

Among the conditions which weaken or destroy the bond formed by Eastman's 910 adhesive are prolonged exposure to high humidity and temperatures. Exposure to temperatures above 212 F for more than 24 hours will destroy the

(*Please turn to Page* 40)

Simple Design Changes Permit
STANDARD RIVETS
to Replace Costly "Specials"

We produce a wide variety of special fasteners for our customers . . . but only when we *have to!* Only when a *standard* rivet just won't fit the application. We bring our experience, skill and engineering know-how to every job, large or small. It's a challenge to see if we can't modify designs to substitute an inexpensive "standard" rivet for a more costly "special".

To improve product appearance and strength
. . . to take full advantage of automatic assembly
. . . to cut delivery time and production costs
—get in touch with Milford first!

THE MILFORD RIVET

MILFORD RIVET & MACHINE CO.
MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

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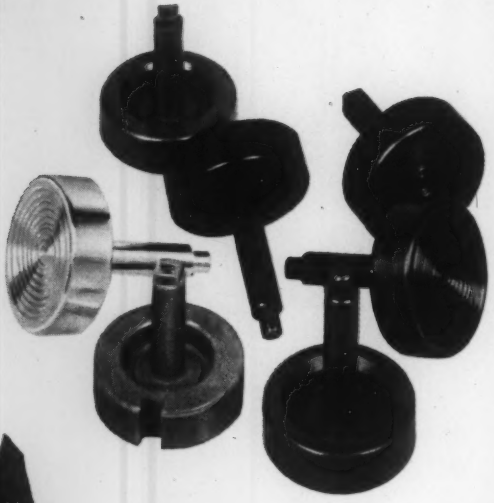


Color...precision...prompted to switch to Alcoa Aluminum*

These jewel-bright buttons on Square D's oiltight pushbutton line command machine tools, move assembly lines, guard lives and sensitive processes. Their colors tell at a glance the functions they perform. Their precision, ±.0005″, keeps them oiltight and smooth working for years.

Square D switched to Alcoa® Aluminum Screw Machine Stock for these parts . . . because metal is desirable to withstand abuse . . . because color anodizing provides a bright, lasting finish that does not distort dimensions . . . because the fine machine finish possible with Alcoa 2011-T3 (10-20 microinches) gives them the precision they need. Above all, costs are lower than any other metal they could have used.

If you machine parts from brass or steel, now is the time to take a hard look at these economic facts about aluminum:

1. Aluminum costs less than brass, and machines just as fast.
2. Aluminum machines faster than steel and won't rust.
3. Aluminum scrap allowance is high.

Now is the time to switch to Alcoa Aluminum. To help you make that switch, call your nearest Alcoa sales office. For immediate delivery of screw machine stock, contact your nearest Alcoa distributor or ALUMINUM COMPANY OF AMERICA, 873-L Alcoa Bldg., Pittsburgh 19, Pa.

SQUARE D COMPANY

Screw Machine Stock

IN PURCHASING,

Howard W. Troyk, Square D's Purchasing Agent (left), discusses Alcoa service with Jack Mayotte of Production Planning. Mr. Troyk says, "We decided on Alcoa Aluminum Screw Machine Stock because Alcoa helped us in solving many of the problems encountered with various applications. Trial lots of material were willingly submitted and requested delivery dates were met."

IN DESIGN,

Paul Goudy, Chief Engineer (left), discusses application of aluminum screw machine parts with designer Earl Mekelburg. Mr. Goudy says, "We selected Alcoa Aluminum for our pushbutton because of its fine combination of strength, consistency of color when anodized, and substantial cost saving!"

ALCOA ALUMINUM SCREW MACHINE STOCK

NEW! "ALCOA THEATRE" Exciting Adventure Alternate Monday Evenings

WE CHOSE ALCOA ALUMINUM SCREW MACHINE STOCK

LEARN WHY OTHER COMPANIES HAVE *SWITCHED TO ALCOA ALUMINUM

Direct quotes from leaders in industry on why they buy from Alcoa. Fill out coupon for your copy.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

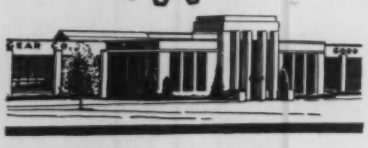
RUSHING THE GROWLER

Those were the days — down to the corner saloon, at the side entrance, you could bring a pail, bucket, or pitcher, and have it filled with cool draft beer — that was "rushing the growler," a real treat back in 1907. If you preferred you could buy good 7-year old bourbon whiskey by mail order for only $3.20 for *four full quarts*. Or if you lived in a "dry" area, you drank patent medicine — for your "health" — that might contain up to 47% alcohol.

Dreaming of the "good old days" is a popular pastime, but it's not at all entirely realistic. There have been many changes since 1907 that we tend to lose sight of; diversions in 1907 were fewer than today — and there was less time to be diverted in! Products have changed too — and most have changed for the better. Gears are an excellent example; the progress in the design, quality and manufacture of gears in the past 50 years has been remarkable. This progress is continuing today at an ever-increasing tempo, providing an important reason for choosing your custom gear source with care — for choosing a firm with demonstrable ability to keep in the forefront of this progress. A firm, in short, with a record like Cincinnati Gear.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
Fifty Years of "Gears — Good Gears Only"

CINTI®



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Engineering News Roundup

(*Continued from Page 37*)

bond. Exposure to water at temperatures near the boiling point will also destroy the bond. Below 170 F prolonged exposure to water will somewhat weaken the bond but not drastically nor permanently.

Still in the nature of a laboratory curiosity, the new adhesive is in limited production.

Meetings

AND EXPOSITIONS

Nov. 19-21—

Investment Casting Institute. Annual Fall Meeting to be held at the Sheraton Hotel, Chicago. Further information is available from institute headquarters, 27 E. Monroe St., Chicago 3, Ill.

Nov. 26-27—

Third International Meeting of the Canadian Aeronautical Institute and the Institute of Aeronautical Sciences to be held at the Royal York Hotel, Toronto, Ont. Additional information can be obtained from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Dec. 1-6—

American Society of Mechanical Engineers. Annual Meeting to be held at the Statler and Sheraton McAlpin Hotels, New York. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Dec. 2-6—

26th Exposition of Chemical Industries to be held at the Coliseum, New York. Additional information is available from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Dec. 9-13—

Eastern Joint Computer Conference and Exhibit to be held at the Sheraton-Park Hotel, Washington, D. C. Sponsors are Institute of Radio Engineers, Association for Computing Machinery, and American Institute of Electrical Engineers.

Jan. 6-8—

Fourth National Symposium on Reliability and Quality Control to be held at Hotel Statler, Washington, D. C. Sponsors are American Institute of Electrical Engineers, Institute of Radio Engineers, and American Society for Quality Control. Additional information can be obtained from Mr. Victor Wouk, Beta Electric Div., Sorensen & Co., 333 E. 103rd St., New York 29, N. Y.

Jan. 13-17—

Society of Automotive Engineers Inc. Annual Meeting and Engineering Display to be held at the Sheraton-Cadillac and Statler Hotels, Detroit. Further information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 27-30—

Plant Maintenance and Engineering Show and Conference, to be held at the International Amphitheatre, Chicago. Additional information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 28-31—

Institute of the Aeronautical Sciences. 25th Annual Meeting to be held at the Sheraton-Astor Hotel, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Feb. 2-7—

American Institute of Electrical Engineers. Winter General Meeting to be held at the Hotel Statler, New York. Additional information can be obtained from institute headquarters, 33 W. 39th St., New York 18, N. Y.

Feb. 4-6—

Society of the Plastics Industry Inc. 13th Annual Technical and Management Conference of the Reinforced Plastics Div. to be held at the Edgewater Beach Hotel, Chicago. More information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

TOUGHER INSULATION!

. . . just one of many General Electric Form G motor* features which can help improve your product and lower your costs!

*NEMA 48- and 56-frames

UNMATCHED DEPENDABILITY of G-E Form G motors is due in part to polyester film insulation, shown here withstanding a 24,000-volt blast.

GENERAL ELECTRIC

Circle 431

HERE'S THE MOTOR YOU NEED - -

MILLIONS OF G-E FORM G MOTORS have been sold since this design, the first in the new NEMA 48- and 56-frame ratings, was introduced five years ago—perhaps the most enthusiastic acceptance of a new motor in history. Today, there's a G-E Form G motor to meet your needs *without* costly "specials."

Try this 3-step program which can help you IMPROVE YOUR PRODUCT AT A SAVINGS!

STEP 1: Call your G-E Apparatus Sales Office. General Electric sales engineers have helped hundreds of customers save countless thousands of dollars by taking full advantage of all the benefits of the G-E Form G motor design. Combine your knowledge of your product with his knowledge of motors, and take . . .

STEP 2: With the help of your G-E sales engineer, choose the exact motor you need from the complete line of G-E Form G motors. Try it on a sample basis. No matter which one you select, it will have all the years-ahead features shown at right, and it will be a proved performer (more than 6 million are in use).

STEP 3: Together, decide how to take maximum advantage of the inherent cost-reducing abilities of the G-E motor. Your discovery may be as simple as that of one manufacturer who found that the close tolerances of the G-E Form G motor permitted him to mount the motor direct, eliminating several costly parts. A very slight adjustment saved him more than 30¢ per unit!

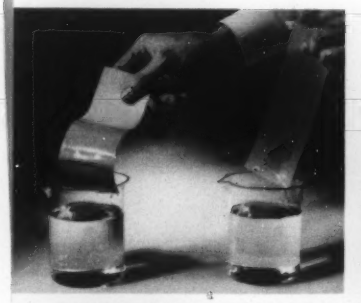
This 3-step program has led thousands of manufacturers into cost reductions. A few examples are shown at right, under the flap. There are hundreds more—like the compressor builder who cut over-all manufacturing costs 25%. Or the pump manufacturer who doubled sales of his streamlined product. Or another who cut his shipping costs by 35%. Or still another who hasn't heard of a motor failure on his product in three years!

The results this program can produce for you are not mythical—they're tangible, measurable benefits that can actually affect your profit picture. A motor that has done so much for so many can help you, too. Why not give it a try? Take the first step today—*call your G-E Apparatus Sales Office now!*

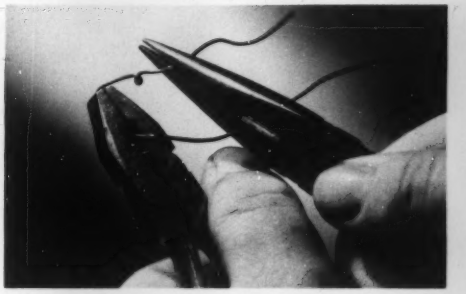
Product literature and actual case histories available on request from General Electric Co., Section 702-61, Schenectady 5, N. Y.

GENERAL ELECTRIC

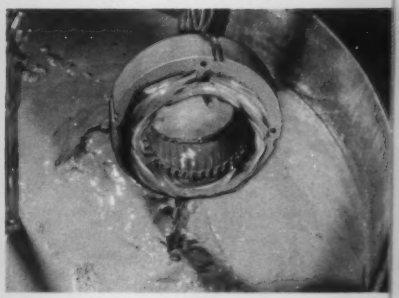
- - - in G-E *Years Ahead* DESIGN



MYLAR* POLYESTER FILM insulation (right) has 35 times the moisture resistance of ordinary motor insulation.

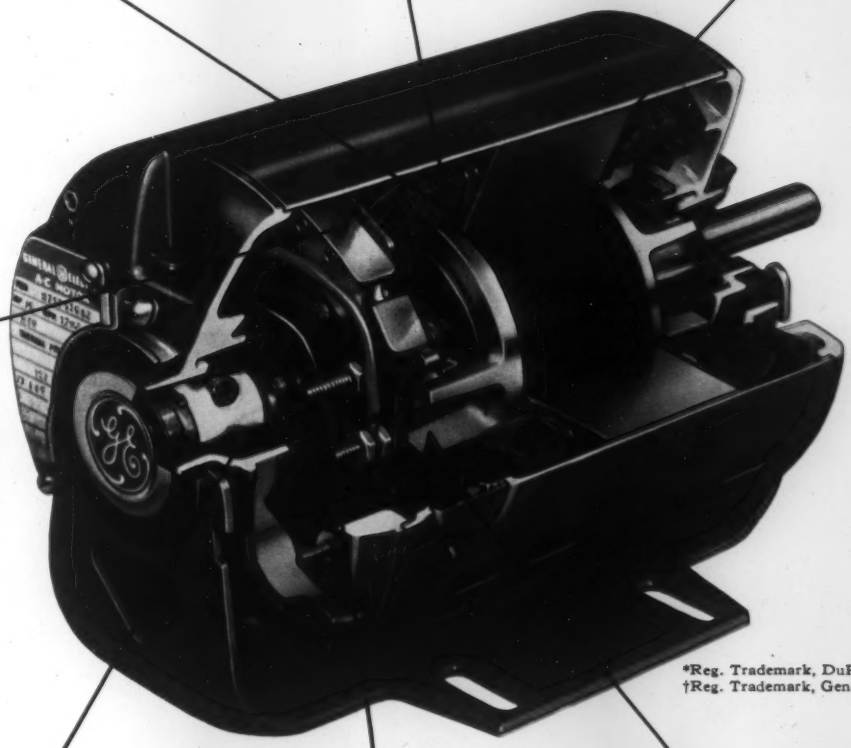


FORMEX† INSULATED WIRE can be bent, twisted, crushed without harm. Also resists heat, moisture, corrosion.



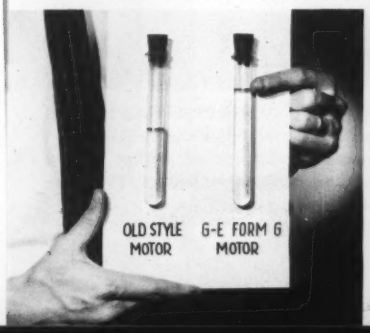
PROTECTIVE VARNISH on entire stator assembly provides protection from moisture, abrasion and rust.

CENTRIFUGAL STARTING MECHANISM is famed for dependability—has performed 3½ million consecutive starts on test.

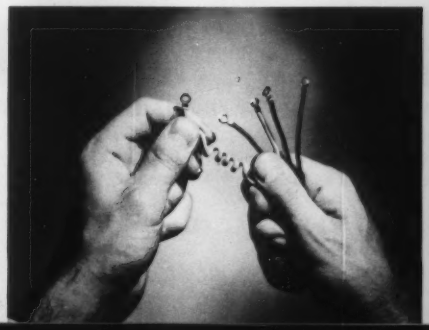


*Reg. Trademark, DuPont Co.
†Reg. Trademark, General Electric Co.

LARGE OIL RESERVOIR holds 50% more oil than old-style designs, contributes to *doubled* lubrication life.

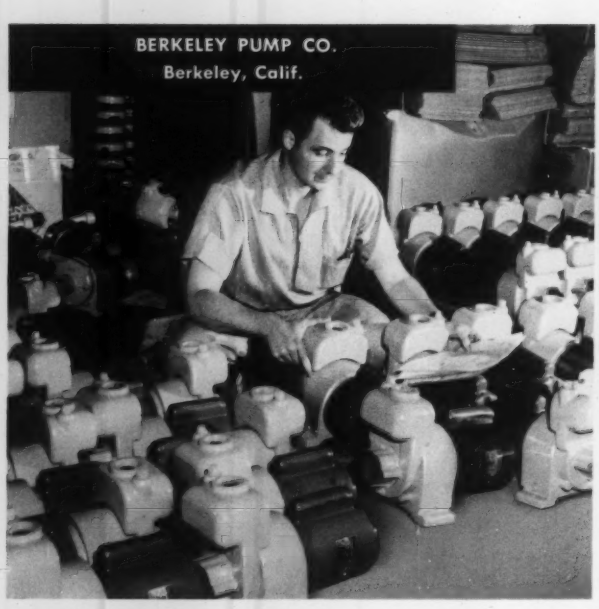


BRAIDLESS NEOPRENE LEADS, permanently color-coded, have great insulating strength and moisture resistance.



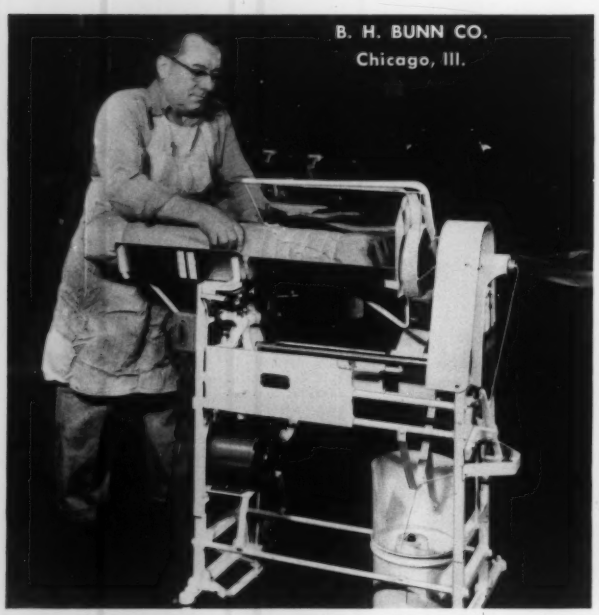
SPEED NUT welded inside motor shell permits fast, easy conduit connection from outside—speeds assembly.

- - - - PERFORMANCE-PROVED MIL

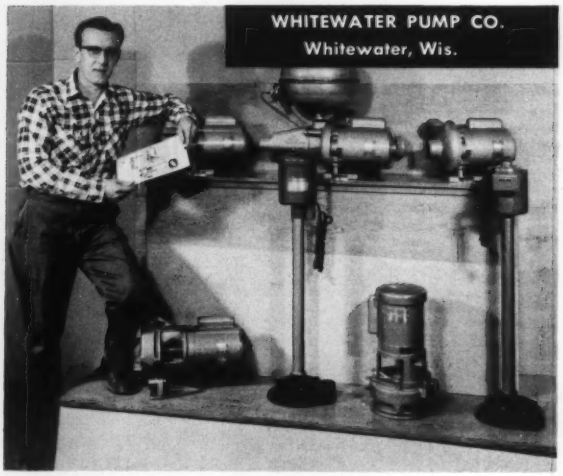


BALANCED DESIGN. "G-E Form G motors give us everything we want for our shallow-well and deep-well jet, centrifugal and swimming pool pumps: moisture protection, plenty of torque and overload capacity, assembly savings, and dependable operation."

TOP PERFORMANCE. "Our automatic poultry feeder requires a motor with enough break-away torque to pull a flat chain through a feeding trough. It must meet tough duty cycles in temperatures from above 100 F to below freezing. We're 100% sold on G-E motors."



WEIGHT SAVINGS. "The G-E Form G motor has speeded assembly, reduced shipping costs, and increased the portability of our tying machine. Complaints are a rarity. In 50 years, we've used nothing but G-E motors. What more can we say?"

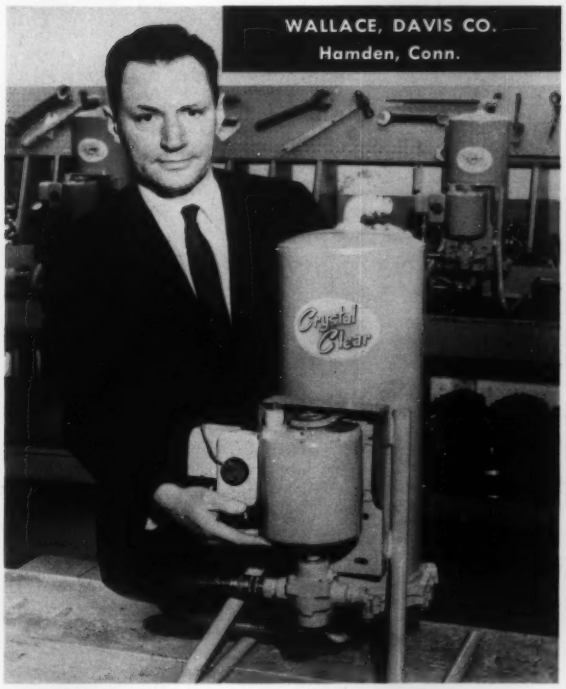


COMPLETE LINE. "We make many types of pumps, but the completeness of G.E.'s line permitted us to standardize four years ago. We've saved time and money, and the Form G motor has added to pump efficiency."

LLIONS OF TIMES OVER!

ALL-ANGLE MOUNTING. "The Form G motor has been used in many different positions on our wire strippers, but it always performs perfectly. In nine years, we've never had to repair or replace a General Electric motor."

DEPENDABILITY PLUS. "An electric motor that leaked oil when installed on our garage door opener would be a serious problem. Since we switched to the G-E Form G motor, we've never had a complaint of any kind. In addition, the G-E motor has simplified our manufacturing procedure, and improved our product mechanically, electrically, and visually. We think the General Electric Form G motor is tops in its field."



EXTREMELY RUGGED. "Our portable filter for swimming pools must survive even hurricanes and blizzards. In 24-hour-a-day tests under the worst conditions, the G-E Form G motor performed flawlessly. It has contined to do so in actual use."

MAXIMUM EFFICIENCY. "To deliver more air with less current consumption, we chose the G-E Form G motor for this all-purpose air compressor. It's quiet, requires little maintenance."

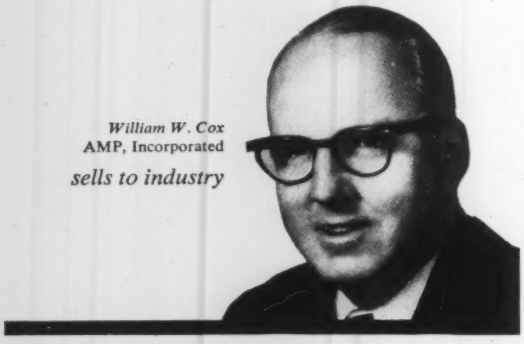
Can specialized business publication advertising actually sell?

By reputation, salesmen are reluctant to credit anything but their own selling efforts for getting names on the dotted line.

Actually, it's quite a different story. The most successful salesmen will tell you two important things about selling. 1. That the selling process is largely a matter of communicating ideas. 2. And that specialized business publication advertising can help importantly to register information with prospects.

Of course each salesman will express this in his own way . . . but they all agree that selling would be far more difficult without the advertising that appears in the industrial, trade, and professional publications that serve the specialized markets to which they sell.

Here, for instance, is what a salesman has to say about this kind of advertising:



William W. Cox
AMP, Incorporated
sells to industry

Says Mr. Cox:

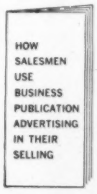
"The quickest way we can introduce a product is by introducing it through advertising in business papers. That way we get it around faster than we can by word of mouth alone. On occasion my home office has inquiries out to me before I can get to the customer or prospect to introduce a new product. They've already seen it in a trade magazine.

"It's interesting to note that within the last two weeks I received a survey which shows about 80% of the new customers we get on our books come through our trade publication advertising. Of course, our company is only 15 years old and we have grown from what you might say, *nothing*, to the biggest in our business. Certainly a lot of that has come from our advertising campaigns. Our name is known throughout the world right now, purely because of our advertising program. When I go to a prospect now, they know my company, they know my product . . . it makes my job easier, and opens doors when I have to make cold calls."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable you can be sure that your business publication advertising is really helping them sell. If too many answers are negative it could well pay you to review your advertising objectives—and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful and effective package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet entitled, "How Salesmen Use Advertising in Their Selling," which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' advertising.



You'll find represented many interesting variations in how they do this. Some are very ingenious; all are effective. You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy. Then, if you decide you want to provide your salesmen with additional copies, they are available from NBP Headquarters in Washington, at twenty-five cents each. Or if you choose you can reprint the material yourself and distribute it as widely as you please. But first, send for your free copy.

NATIONAL BUSINESS PUBLICATIONS, INC.
Department 4D
1413 K Street, N. W.
Washington 5, D. C. **STerling 3-7533**

Please send me a free copy of the NBP booklet "How Salesmen Use Advertising in Their Selling."

Name _____

Title _____

Company _____

Street Address _____

City _____ Zone _____ State _____

National Business Publications, Inc.

NBP

. . . each of which serves a specialized market in a specific industry, trade or profession.

(Advertisement)

VOL. 2—NO. 4

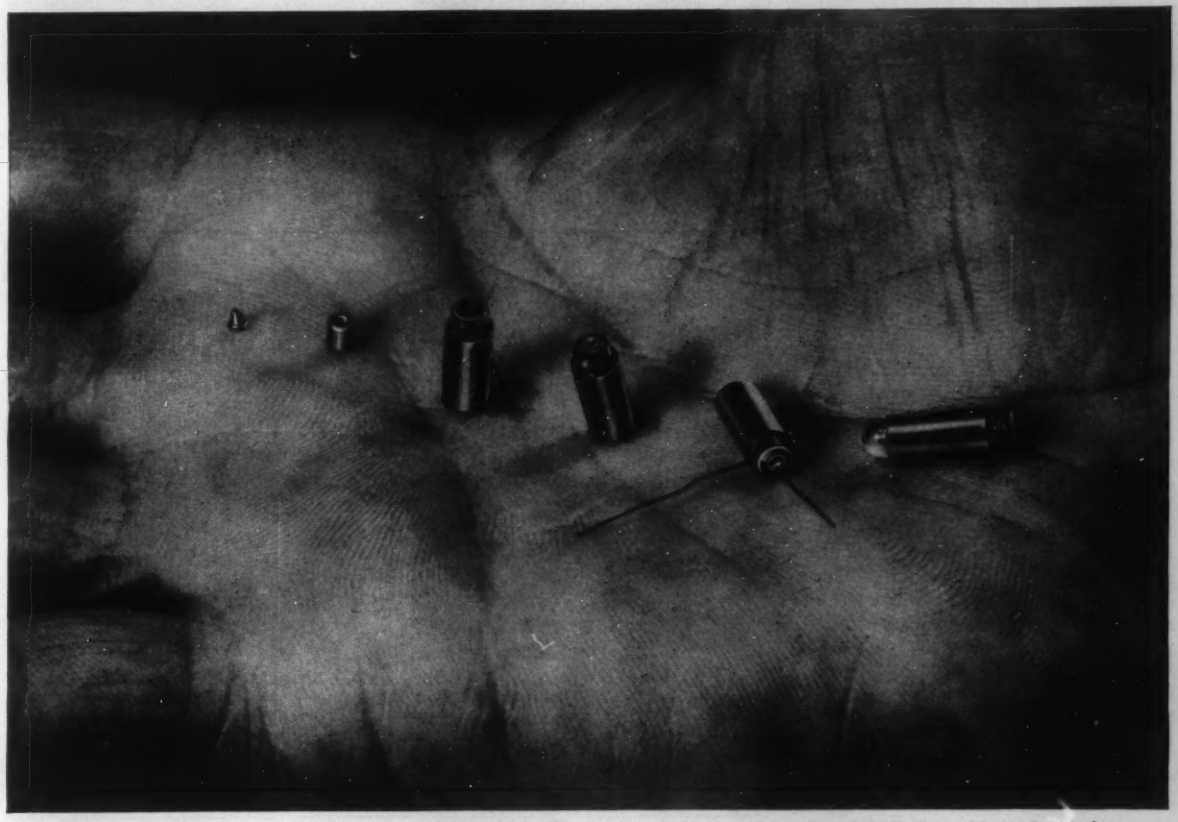
NEWS OF MATERIALS THAT ARE IMPROVING TODAY'S PRODUCTS

THE NATIONAL SCENE

©1957, National Vulcanized Fibre Co.

PUBLISHED BY NATIONAL VULCANIZED FIBRE CO., MANUFACTURERS OF:

VULCANIZED FIBRE • PHENOLITE® LAMINATED PLASTIC • NATIONAL NYLON



This tiny surgical lamp posed a difficult materials problem. The insulator base (second part from left) had to: withstand sol lering temperatures, be strong enough for press-fitting operation, serve as an electrical insulator, accommodate drilling with high speed tools (.040-in. dia. hole). Only Vulcanized Fibre met all these requirements. And did it at lowest cost!

IMPROVE YOUR PRODUCT . . .

For better results in less time, more and more designers are using National's services

No stranger to the complexities that face designers in product development and improvement, National builds its services around designer needs. Experience, plus the broadest line of laminated plastics in the industry, make this possible.

National's services are keyed to two stages of design decision: *materials selection*—involving comparative properties, characteristics and costs; and *materials performance*—involving function, workability, tolerances, appearance and, again, costs.

Because National manufactures the broadest line of these materials—our latest is extruded Nylon—we can give an unbiased recommendation in selecting the *one best material* to do a given job. Because we fabricate these materials by the ton, we can offer practical, cost-saving design tips gained from experience in turning thousands of designs into precision parts. And we can go further . . . to machine, form or post-form the part to your design specification.

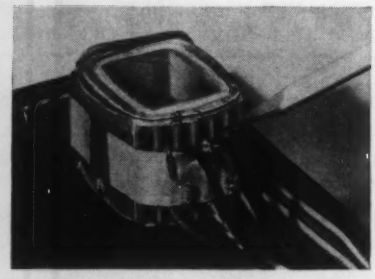
Our files are filled with examples of how we have helped manufacturers reduce unit cost, produce a better product, or do both. The solutions vary from a simple switch in materials to furnishing the same material in an easier-to-use form or size. In many cases new materials and grades have stemmed from a single designer's need.

Whether you are now evaluating a present design or working on a new product, chances are that our services can help you . . . ▶

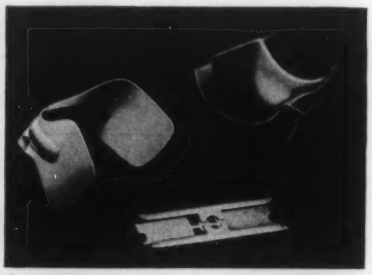
Circle 433 on Page 19

. . . improve your product mechanically

If you face problems of weight, strength, noise, heat, durability, finish, texture, corrosion—singly or in combination—check National's materials. PHENOLITE, versatile Vulcanized Fibre and extruded Nylon offer a wide range of possible solutions to basic mechanical design problems. These products represent over 100 grades from which you can select the one best material at the lowest cost. Write for a copy of "Selecting the One Best Material," 16-pages of important material selection data.



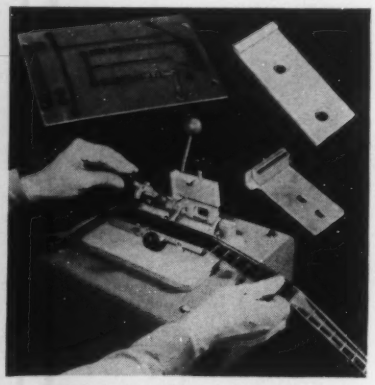
Basically chosen for its electrical insulating qualities, new .010 corrugated Vulcanized Fibre replaces wrapped insulation papers, but, mechanically, also reduces unit weight and assembly time, and supports transformer wiring and radio components.



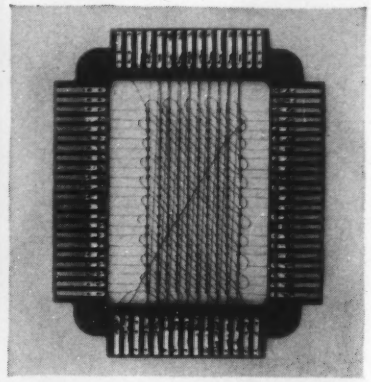
Toughness, durability, and resilience of Vulcanized Fibre combine with unique formability to solve a wide range of design problems. Shown here are: athletic guard piece; welder's helmet (7-in. deep draw); and complex electrical insulator.

. . . electrically

From high voltage transformer and switchgear applications to printed circuitry, PHENOLITE and Vulcanized Fibre are used across-the-board as basic electrical insulating materials. Available in a variety of resins and base materials, PHENOLITE laminated materials can meet your critical needs for high dielectric strength. Vulcanized Fibre is unsurpassed for arc resistance. Because a large segment of National's research is directed at producing even better electrical insulation at lower cost, a continual flow of new grades permits you to "design ahead electrically." Keep posted on these developments by reading "The National Scene" regularly. Contact your National representative.



A new dielectric film splicer uses high-frequency heat to fuse film instantly. Copper-Clad PHENOLITE for printed circuits cuts cost of device. PHENOLITE electrode blocks give complete resistance to carbonizing.



Pinhead-size cores strung on copper-wired PHENOLITE frames are used in IBM's 760 Control and Storage Unit. Each has printed circuit type terminal strip. PHENOLITE must be strong, punch clean, etch well, lay flat and withstand dip-solder temperatures.

. . . at lower cost.

Design can contribute directly to lower unit costs by simplification or choice of a lower cost material, *if* the benefits are not offset by higher tool costs or rate of rejects. Here is where National's fabricating service can help. First, you gain the benefit of fabricating experience with many materials over a countless range of size and configuration. Second, you gain specialized skills in tool design. Third, you are certain of 100% usable parts, delivered timed to production needs. For the complete story, write for "Management Decision for Profit," 12 pages of facts on fabricated parts and components.

One of many large punch presses at National. Fibre parts are being pierced, scored and blanked in one operation with compound die. Particular piece is fungus-treated for refrigerator application.

On the opposite end of the scale from the batteries of presses, lathes and screw machines, special machines designed and built by National are used to form Fibre into strong, intricate shapes.

(Advertisement)

Call your National Representative early in the design stage. Benefit from the full range of services oriented to the designer's need. Benefit, too, from the PHENOLITE "In-Stock" program—over thirty grades in a variety of sizes and thicknesses available for immediate shipment.

Next Monday Call:

Baltimore	VAlley 3-0393
Boston	TWinbrook 4-3500
Chicago	VAn Buren 6-8060
Cincinnati	GArfield 1-0632
Cleveland	CHerry 1-2086
Dallas	DAvis 8-1733
Detroit	UNiversity 3-3632
Griffin, Ga.	GRiffin 8-1308
Indianapolis	WAlnut 3-6381
Los Angeles	RAymond 3-3129
Milwaukee	BRoadway 6-6995
New Haven	LOcust 2-3594
Newark	MItchell 2-6090
New York	COrtlandt 7-3895
Philadelphia	SHerwood 8-0760
Pittsburgh	FAirfax 1-3939
Rochester	HIllside 5-0900
St. Louis	PArkview 5-9577
St. Petersburg	5-5505
San Francisco	DAvenport 6-4667
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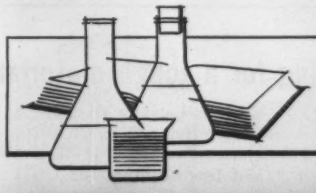
IN CANADA:

National Fibre Co. of Canada, Ltd.

Toronto	LEnnox 2-3303
Montreal	AVenue 8-7536

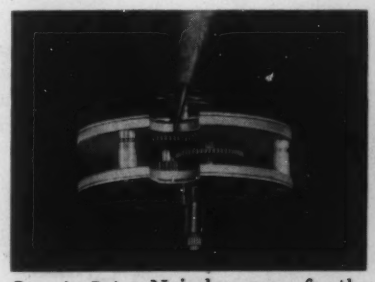
LIVE BETTER ELECTRICALLY



OUT OF THE LABS

General Electric-Telechron clocks use three precision PHENOLITE gears for quiet operation, long life, economy.

Critical design, manufacture or operating requirements often rule out the use of standard materials. For this reason, an important activity of the National Laboratories is the development of materials specifically modified to meet critical customer needs.



Case in Point: Noiseless gears for the fine precision movement of General Electric-Telechron clocks. This particular application demands a material with high dimensional stability —one which is not appreciably affected by temperatures up to 200° F. It must also be punched easily into small blanks which can be hobbed without prohibitive tool costs. To operate with minimum wear and noise, the gear must be strong and clear cut. And since it runs continuously in a sealed bath of light oil, it must be impervious to such lubricants.

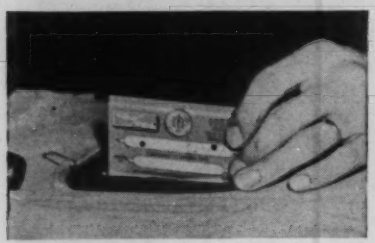
Solution: National's development of a new PHENOLITE. This special gear stock is made with a high strength cotton paper impregnated with a phenolic resin. By modifying this resin and by following certain treating and molding procedures, a thin laminate can be made which fulfills *all* of the requirements for this gear.

Results: For the past ten years, National has supplied the Clock and Timer Dept. of General Electric Co. with this special PHENOLITE gear stock. Previously, using a fabric-base laminate, hobs had to be resharpened after cutting only a few arbors. But now it is not uncommon to realize a 500% increase in the number of arbors cut before resharpening. This means an increase of 500% more gears per operation. In addition to this economy, the gears stand up without failure.

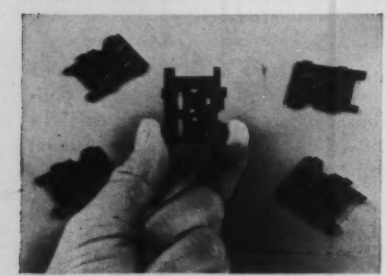
Circle 433 on Page 19

DESIGNERS ARE USING

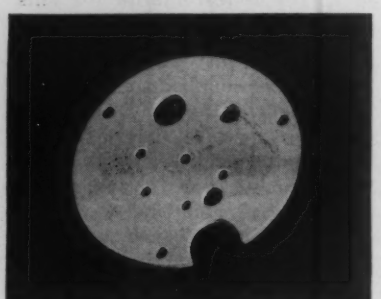
Semi-flexible Vulcanized Fibre as top lift on women's spike heels. Wears better than leather, does not crack like other materials and is not hard or slippery like nylon. Saves from ½ to 6c per pair.



Special white Fibre, .020-in. thick, for race track machine-recorded passes that speed patrons and employees through admission gates. Fibre can be punched, has dimensional stability, can be lithographed, and stands the abuse of daily use.



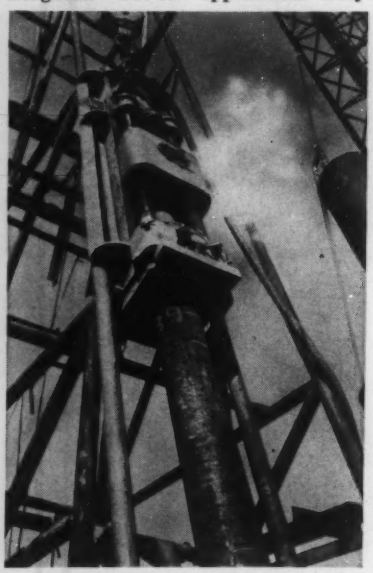
PHENOLITE X-112, *odorless* material, for switch panel in air conditioning, refrigeration and temperature controls. Does not contaminate foodstuffs, is strong, easy-to-fabricate and relatively low cost.



White Vulcanized Fibre for gear train base plate in precision timing mechanism. Oil-resistance of fibre is a vital factor since gear mechanism is enclosed in metal housing and runs continually in a light lubricating oil.

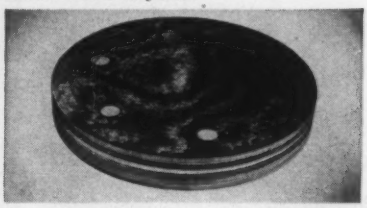
Looking for a tough material?

Vulcanized Fibre is used in thousands of products—from delicate surgical instruments to safety helmets for "Little Leaguers." Yet few applications truly test Fibre's toughness. This one does. To learn more about this amazing material, write for Booklet, "Fibre In Industry." Use coupon below.



Fibre cushions pile driver blows to safeguard steel piles against splitting. The heavy ram can buckle or split unprotected steel piles. Fibre is the low-cost answer over all other materials.

This 14 in. diameter disk takes a 10-hour battering from the 9-ton hammer before it must be replaced. Merritt, Chapman & Scott's subsidiary, Savin, has used these disks for over 10 years.



Vulcanized Fibre disk is "built-up" with several sections to a 2-inch thickness. The material is available in a complete range of sizes, in sheet, tube or rod form.

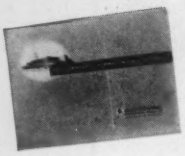
NATIONAL VULCANIZED FIBRE CO.

Dept. G-11, Wilmington 99, Del.

Please send me literature checked below.

☐ A. Materials Selection Guide 16 p.

☐ C. Fabricated Parts Booklet. 8 p.



☐ B. "Fibre In Industry" Booklet. 20 p.

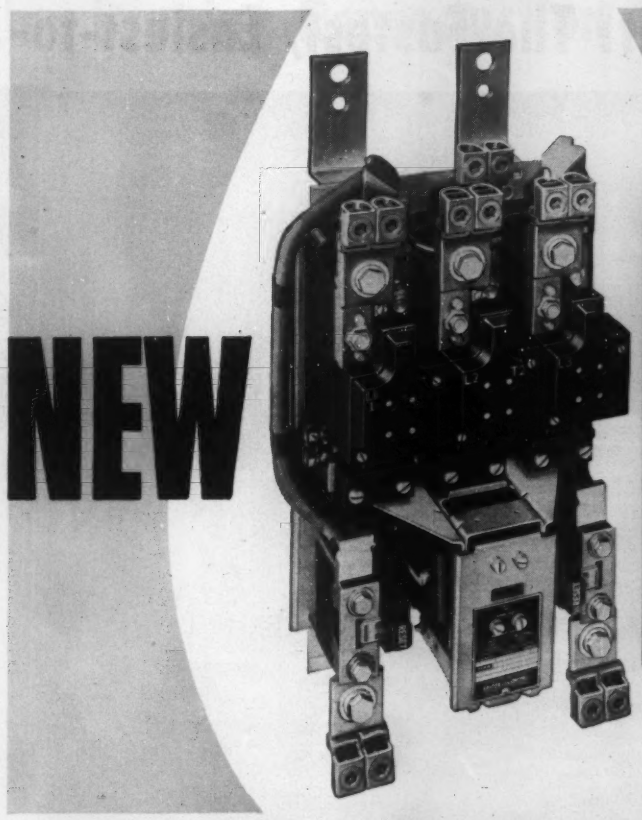
☐ D. Nylon Data Folder. 6 p.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



NEW SQUARE D Vertical Action SIZE 5 STARTER

Smaller! REQUIRES ONLY 270 SQUARE INCHES OF SPACE

DESIGN LEADERSHIP FEATURES IN SQUARE D's COMPLETE LINE OF VERTICAL ACTION STARTERS—SIZE 0 through 5

What's most important in a motor starter?

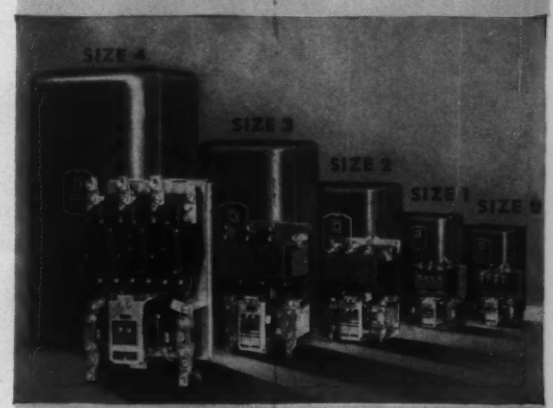
Performance and **long life** come first, naturally—and Square D's straight line guided motion and heavy-duty silver alloy contacts assure both. But that's only the beginning—

Fast wiring is important, too. Square D gives you a lot of wiring space and time-saving solderless terminals.

Easy maintenance rates high. The coils, contacts and overload relays on all Square D starters can be changed in a jiffy... without disturbing external connections. A screwdriver is all you need. And—

"Off-the-Shelf" Parts Kits make normal maintenance and "on-the-job" modifications easier than ever. Packaged parts include interlocks, contacts, coils, overload relays, pushbuttons and selector switches. They're easy to buy, easy to identify and faster to install.

For the complete story, write for Bulletin 8536 Square D Company, 4041 N. Richards St., Milwaukee, 12, Wis.



EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT... NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

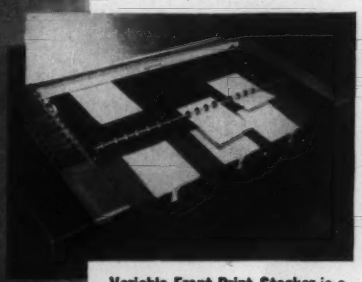
Now when you need it! The Fastest, Easiest-to-

● 7,500–5,000 WATT LAMP FOR SUPER-FAST EXPOSURES
● MECHANICAL SPEED OF UP TO 75 FEET PER MINUTE
● SELECTIVE FRONT OR REAR PRINT DELIVERY
● LARGE 46-INCH PRINTING WIDTH

Use Bruning Reproduction Machine Ever Built!

New Copyflex Model 575

Here is the one whiteprinter designed in every way for big volume reproduction! New speed, new operator conveniences, new printing quality are combined in the "575"—now when you need them—to help meet today's increased print demands.



Variable Front Print Stacker is a Bruning exclusive! Control knob advances or retracts stacker for efficient, side-by-side stacking of prints.

Tracing Stacker Tray has special guide-rollers to assure flat, consecutive stacking of various size originals. Tray is 46 inches wide, 12 inches deep.

Faster, Heavy-Volume Production. With the "575" you can boost your average operating speeds up to 250%. It offers a super-fast mechanical speed of up to 75 f.p.m., a 7,500-5,000 watt exposure lamp, and a wide 46-inch printing width, The powerful two-stage lamp can be operated at either 7,500 watts or 5,000 watts with the flick of a switch. It extends beyond the printing width at either side to provide uniform exposure.

More Operator Conveniences. A host of time-saving conveniences include: one-knob speed control with perfect automatic synchronization of print exposure and development, automatic separation of exposed prints from originals, automatic stacking of tracings and prints, front or rear delivery, and a lamp shield control that facilitates reproduction of extra-fast printing originals.

The new Model 575—like all Copyflex machines—is clean, quiet, and fume-free—gives you problem-free installation and operation. No exhaust venting, no plumbing, no auxiliary equipment. It's the greatest Bruning machine ever built! It offers you the greatest savings ever in time and man hours! Mail coupon now for special descriptive literature.

BRUNING Copyflex

Best Process • Best Machines • Best Selection of Materials

---------- Send for your free copy! ----------

Charles Bruning Company, Inc., Dept. 113-K
4700 Montrose Ave., Chicago 41, Ill.
In Canada: 105 Church St., Toronto 1, Ont.

Please send me information on the new Copyflex model 575.

Name_____ **Title**_____

Company_____

Address_____

City_____ **County**_____ **State**_____

Circle 435 on Page 19

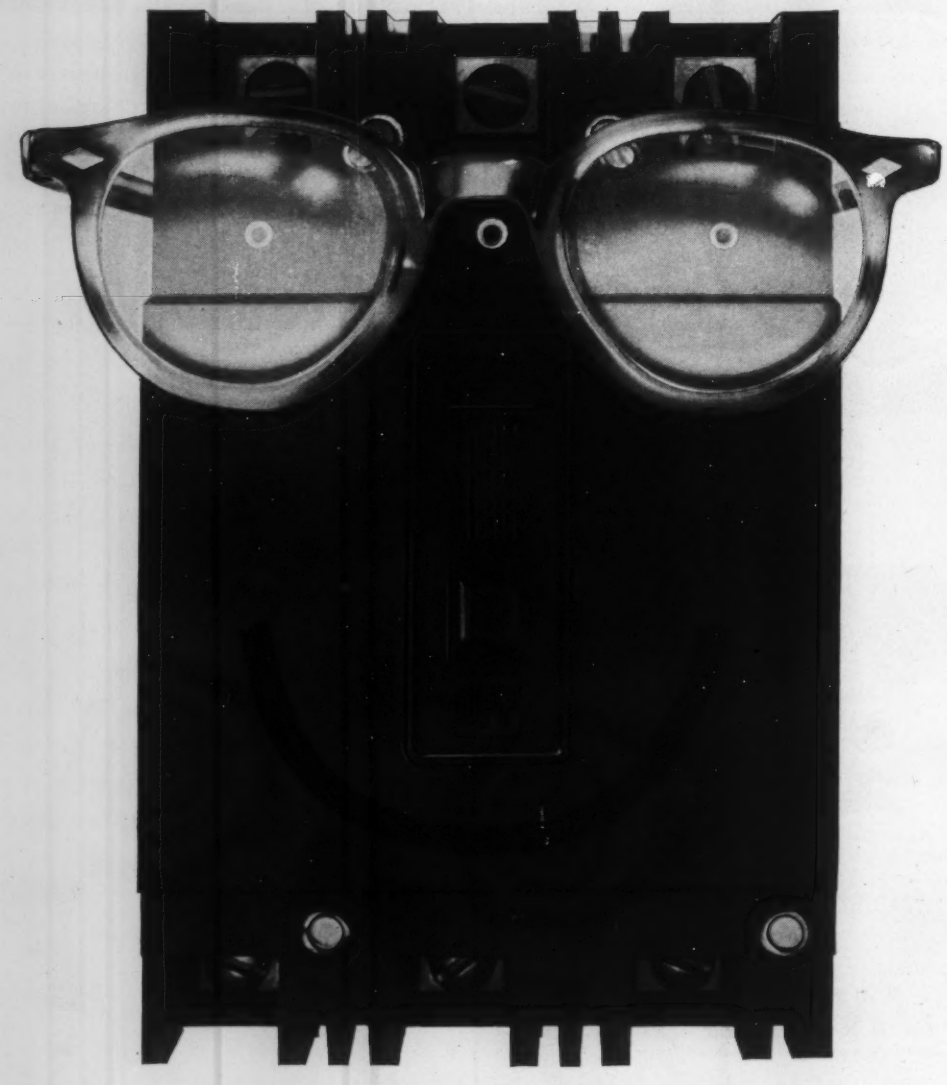
Take a look at THE SMALLEST, LOWEST COST 100-amp BREAKER for 480-volt applications

This new Westinghouse EH Breaker represents a major breakthrough in molded case circuit breaker design. The 3-pole unit shown is 40% smaller than the industry-standard Type F Breaker (only 4⅛″ wide, 6½″ high and 3-31/32″ deep). Rated at 100 amps, 480 volts AC, the new EH breaker will handle an estimated 95% of all 100-amp industrial breaker applications.

For fluorescent lighting circuits, the new Westinghouse EH design provides the first single pole breaker for 277 volt AC in ratings higher than 20 amperes.

In addition, a variety of accessories are available for the new breaker, including: shunt trip; alarm switch; vari-depth handle; rear connecting studs; and plug-in mounting blocks for switchboards.

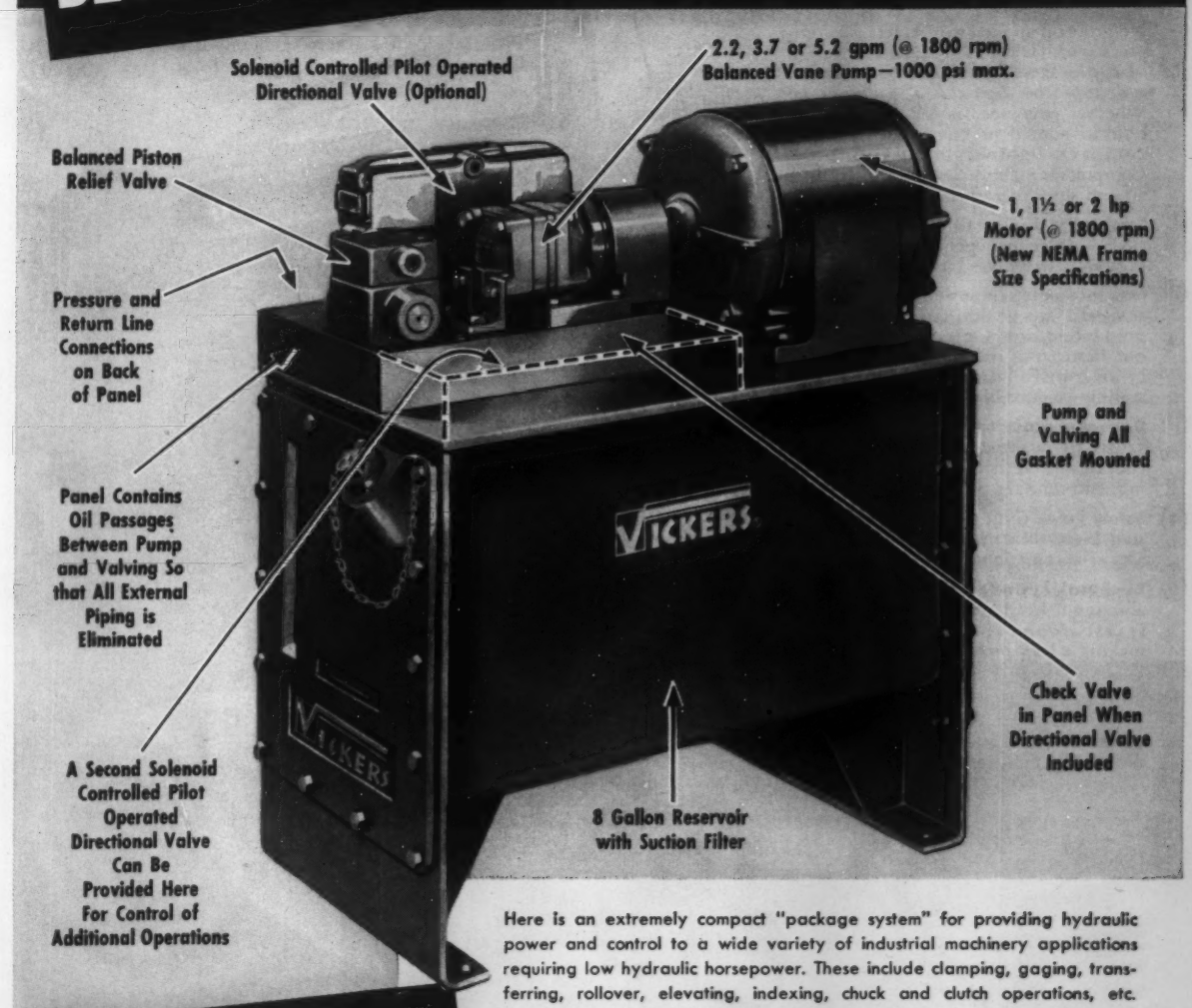
For complete information on prices and application, contact your nearby Westinghouse Sales Office, or write: Westinghouse Electric Corp., Standard Control Division, Beaver, Pennsylvania. J-30282



ACTUAL SIZE. Full line of new, smaller Westinghouse EH Breakers includes: 100 amp, 480 volt AC, 2 & 3 pole—100 amp, 250 volt DC, 2 & 3 pole—100 amp, 277 volt AC, 1 pole.

YOU CAN BE SURE...IF IT'S Westinghouse

BETTER DESIGN . . in hydraulic power and control systems


Solenoid Controlled Pilot Operated Directional Valve (Optional)
2.2, 3.7 or 5.2 gpm (@ 1800 rpm) Balanced Vane Pump—1000 psi max.
Balanced Piston Relief Valve
1, 1½ or 2 hp Motor (@ 1800 rpm) (New NEMA Frame Size Specifications)
Pressure and Return Line Connections on Back of Panel
Pump and Valving All Gasket Mounted
Panel Contains Oil Passages Between Pump and Valving So that All External Piping is Eliminated
VICKERS
Check Valve in Panel When Directional Valve Included
A Second Solenoid Controlled Pilot Operated Directional Valve Can Be Provided Here For Control of Additional Operations
8 Gallon Reservoir with Suction Filter

VICKERS®
Series T8
HYDRAULIC
PIPELESS
POWER PACKAGE*

7311-R

Here is an extremely compact "package system" for providing hydraulic power and control to a wide variety of industrial machinery applications requiring low hydraulic horsepower. These include clamping, gaging, transferring, rollover, elevating, indexing, chuck and clutch operations, etc.

Note the many features indicated on the photograph above. The result is improved and simplified hydraulic design . . . also reduced installation and maintenance costs. This "package system" has great flexibility . . . is available in a wide variety of combinations of standard components assembled to suit individual requirements. Pretested and ready for immediate operation, it has also the advantage of undivided Vickers responsibility. For further information, ask for installation drawings 178706-8.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

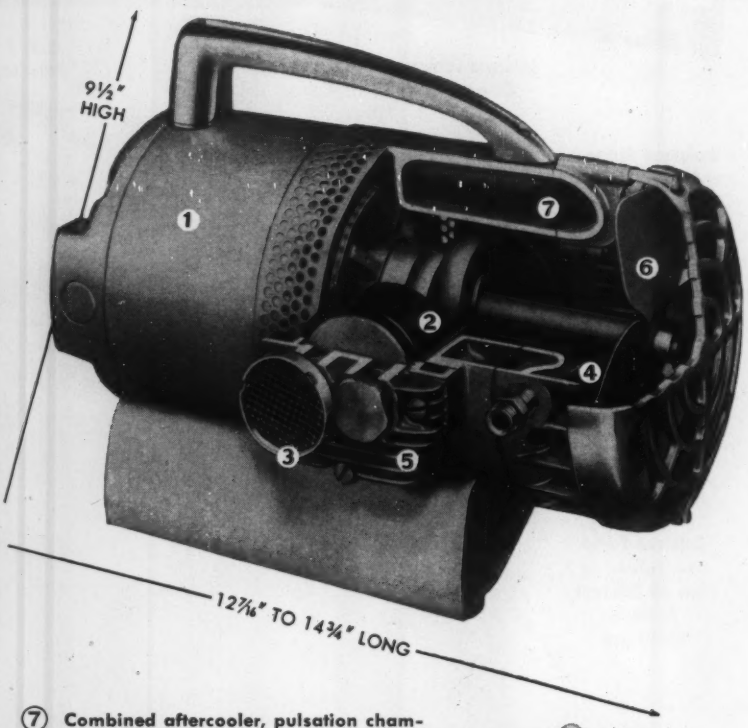
*These "package systems" supplement the Vickers line of standard hydraulic power units.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Oil-Free COMPRESSED AIR

from a portable or built-in unit

No more oil-spoiled work! Here is a compressor which doesn't require lubrication of any kind—eliminates an oil separator, *ends expensive lubrication maintenance!* Whether your need is for a portable or built-in source of compressed air, the compact, lightweight B&G Oil-less Compressor assures cleaner, cooler, drier air and smoother operation.



① **Specially designed motors.** Built by B&G—noted for dependability. Ball bearings are *permanently* grease packed.

② **Graphite piston rings and skirts.** Made of a special composition which does not need lubrication. Operate for years without destroying the mirror-finish of the cylinder walls. Piston ring joints are self-sealing—reduce blow-by to a minimum.

③ **Dry valve construction.** Inlet and exhaust valves are positive-sealing without presence of oil. Precision lapped—self-cleaning—no rubbing parts.

④ **Safety valve.** (Not visible.) Provides constant bleed-off at maximum pressure. Also acts as automatic moisture drain.

⑤ **Bi-metal cylinder head.** Deep-finned aluminum head transfers heat faster. It is cast around the cast iron cylinder, making a leak-proof shrink-fit...no gasket needed.

⑥ **Blast cooled.** The fan blasts great volumes of air over the pulsation chamber, connecting rods, bearings, cylinders and motor. Low temperature operation assures higher efficiency, longer life.

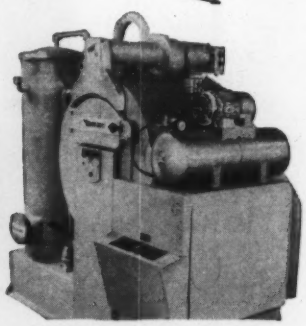
⑦ **Combined aftercooler, pulsation chamber, moisture separator.** Cooler, drier air is delivered at smooth, uniform pressure because of this integrated design.

For complete information on B&G Oil-less Compressors and Vacuum Pumps, send for Catalog GO-1156

Cart mounted B&G Air Compressor

B&G "Duplex Unit" mounted on horizontal tank

New type air stapler with air supplied by B&G Compressor



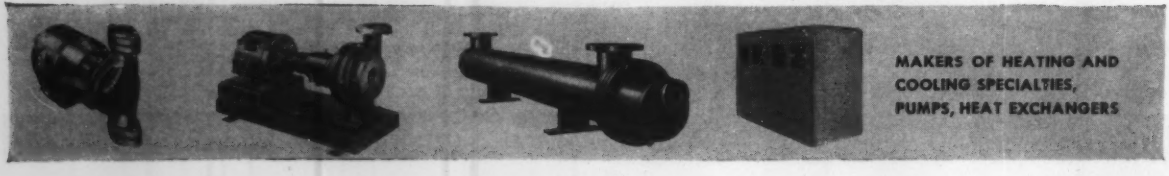
B&G Compressor built into dry cleaning machine

Oil-less AIR COMPRESSORS

BELL & GOSSETT COMPANY

Dept. FA-67, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Dr., Toronto 16, Ont.



MAKERS OF HEATING AND COOLING SPECIALTIES, PUMPS, HEAT EXCHANGERS

NOW..3 new International V-8's

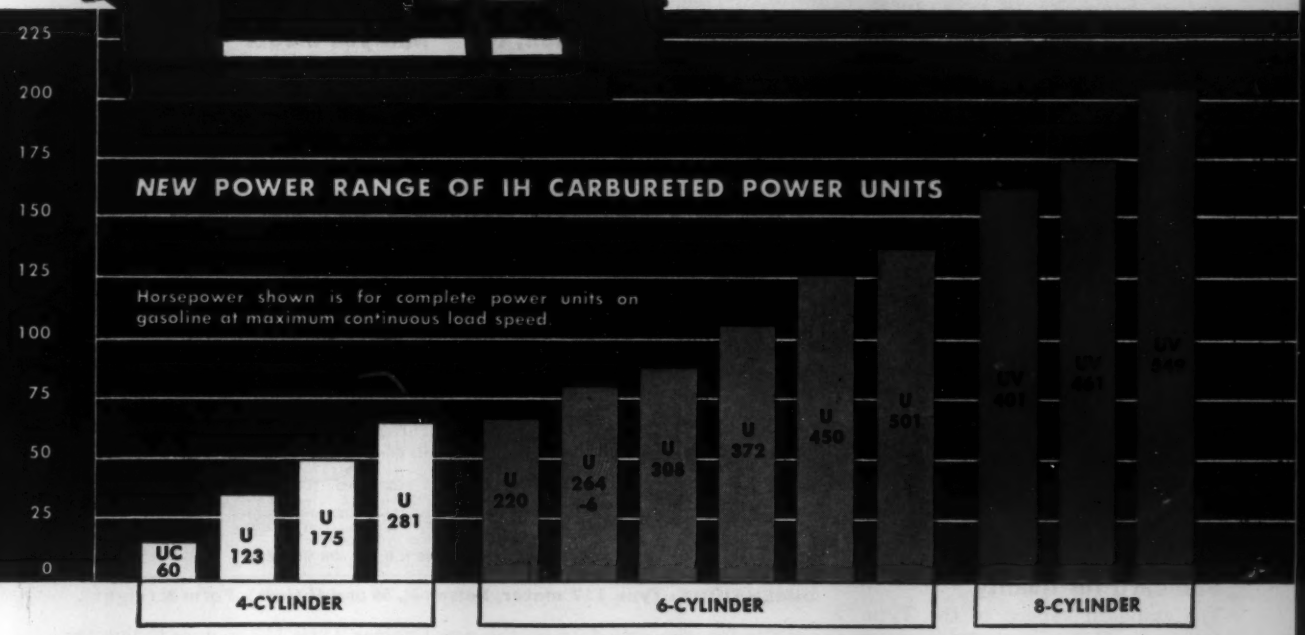
Now you have an even wider selection of economical International gasoline or LP-gas power for your products—three new power-packed, compact V-8's—the UV-549, UV-461, and the UV-401.

NEW V-8 UV-549 POWER UNIT. 208 net hp @ 2,600 rpm on gasoline, complete as shown. Not shown: UV-461 Power Unit—174 net hp @ 2,600 rpm, and the new UV-401 Power Unit—160 net hp @ 2,800 rpm.

These new models increase the International carbureted line to 13 models ranging from 16 to 208 hp on gasoline at continuous rated rpm, complete with regular accessories, fan and radiator. As stripped engines, they develop from 17 to 257 hp. LP-gas power is approximately the same as gasoline.

And just look at the standout V-8 features that help your customers cut operating costs: rigid, Y-shaped block; short-stroke, heavy-duty, cam-ground, 4-ring aluminum pistons; big, smooth-running, counterbalanced, tocco-hardened, 5-bearing crankshaft; large-area, long-life, tri-metal, replaceable bearings; combination full-flow, by-pass filter for long-life pressure lubrication; full-power, down-draft carburetion; oil cooler; and a 12-volt electrical system.

Our service to you will match the famous IH world-wide parts and service facilities that support these engines on the job—anywhere. Call in our experienced installation engineers or get pilot engine models for your research and testing before you specify. Your call or letter will get the special attention you need—fast.



INTERNATIONAL® CONSTRUCTION EQUIPMENT

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors... Self-Propelled Scrapers... Crawler and Rubber-Tired Loaders... Off-Highway Haulers... Diesel and Carbureted Engines... Motor Trucks... Farm Tractors and Equipment.

Circle 439 on Page 19

(Advertisement)

New timing motor rated 60 in-oz torque...

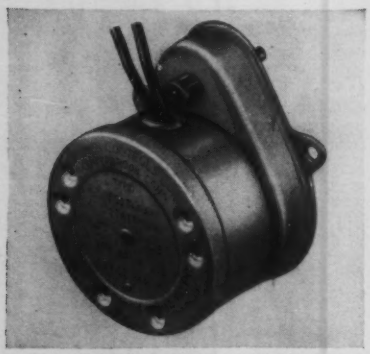
New permanent magnet motor series by Cramer includes "double-strength" and military versions

High torque output, truly synchronous operation, instant starting and stopping, are inherent features of permanent magnet timing motor design. These advantages have been optimized in the new Cramer Type 117, resulting in a motor line with maximum application flexibility.

Five basic versions

Series 117 comes in five basic forms (1) Form P, the standard, highest quality 30 in-oz (at 1 rpm) instrument motor, (2) a militarized version of Form P, (3) Form H, a "double strength" version, (4) Form M, for economy in high volume use, and (5) Form N, a compact, cylindrical gear-train model.

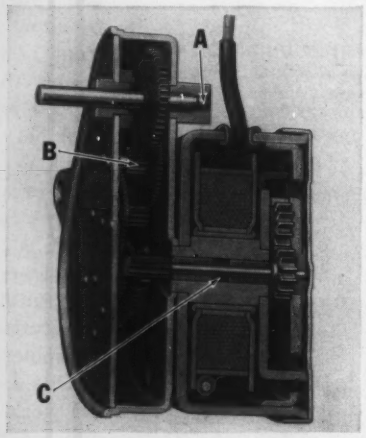
All have these features: instant starting, absolutely synchronous operation, and permanent magnet braking. Coil voltages up to 250V ac, 50 and 60 cycles. Input less than 2.5 watts at rated voltage. Temperature rise only 35°C. Ambient temperature range −20°F to +130°F. Gears all hobbed, with drawn pinion rod. Underwriters' Laboratories approved.



NEW CRAMER TYPE 117 MOTOR. The Type 117 motor, in its several forms, replaces Cramer Types 111, 112, 113, 114 with greatly improved performance.

Standard for quality

The standard version of the Type 117 motor, Form P, is rated 30 in-oz torque at 1 rpm. It's ideal for instruments and industrial control devices requiring field-proved dependability, timing accuracy and longest service life. Oilite rotor bearings, bronze upper and lower output bearings, and a ball thrust bearing backing up the output shaft give exceptional life and performance. A soldered gear cup cover keeps dirt out and lubricant in. Over 100 available speeds from 1 rev. per second to ½ rev. per day.



IMPROVED BEARINGS help double life expectancy of Type 117 motors. Forms P, H feature ball thrust (A) in lower output bearing. All forms boast hobbed gears throughout (B), and Oilite rotor bearings with permanent supply reservoir (C).

Double-strength version, too

Type 117 is offered also in a "double-strength" model, (Form H) rated 60 in-oz at 1 rpm. Applications are in heavy chart recording devices, high speed counters and the like, requiring high torque at fast speeds—as, for example, in the Cramer Type 640E running time meter which reads in 1/10 seconds. Readily available in speeds 60 rpm to 2 rpm. Like the Form P, external finishes are tin and cadmium plate, protected by clear iridite.

A form for economy

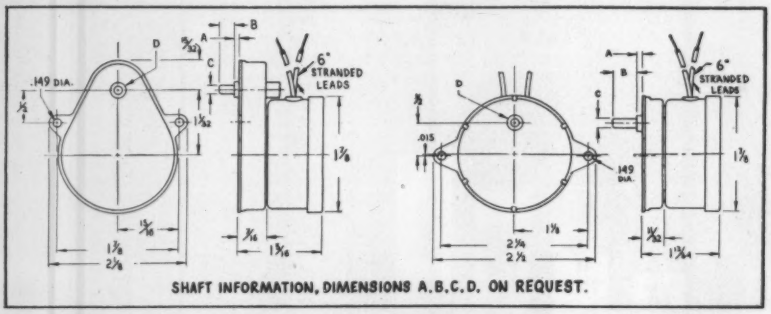
Economy for volume applications is dominant in the Type 117, Form M motor. It has the same torque and wide variety of speeds as the standard industrial version, Form P, above. A few differences: Ball thrust bearing is not used. Gear cover is crimped (instead of soldered) and external finishes are natural brass and black oxide. Advertising displays, appliance timers, vending machines are typical applications.

This one saves space and money

A space-saving cylindrical gear train —same diameter as the basic motor— is the big feature of Form N, Type 117. Basic motor is the same as the economical Form M above. Ideal for limited space applications, Form N is offered in speeds from 60 rpm to 1/12 rpm.

MilSpec model

The militarized version, identified as "Form P, Military," is practically identical with the standard version except for the coil which (here) is vacuum impregnated and supplied with high-temperature rated insulation on the leads. Ambient operating temperature range −55°C to +85°C.



DIMENSIONS: Type 117 motor, Forms P, M and H (left). Form N (right).

Write for complete data on the new Cramer Type 117 motors today. Or better yet, ask your nearest Cramer representative to tell you about them. Cramer Controls Corporation, Box 6, Centerbrook, Connecticut. 7.30

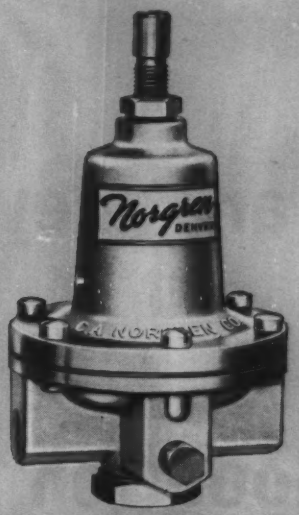
TALK IT OVER WITH

CRAMER CONTROLS
CORPORATION

Circle 440 on Page 19

For BETTER CONTROL of FLUIDS...

Specify *Norgren* CONTROL VALVES



DIAPHRAGM TYPE VALVES

Automatically protect against damage from excessive pressure build-up. Provide controlled operation for fluid recirculating systems.

Easily adjusted to relieve at desired pressure. Relief settings: 0-15 psi, 0-50 psi, 0-75 psi, 0-125 psi, 0-250 psi for pipe sizes ⅛" through ½", and 0-15 psi, 0-50 psi, 0-75 psi, 0-125 psi for ¾" and 1" pipe sizes.

POP SAFETY VALVES

Prevent the build-up of dangerous, excessive pressures in air tanks. Valve automatically pops open at desired setting. Pipe sizes ⅛", ¼", ⅜" and ½".

LOW FLOW RELIEF VALVES

Small, inexpensive valves suited for a wide variety of uses requiring relief at low rates of flow. ⅛" and ¼" pipe sizes.

FLOW CONTROL VALVES,

Two-Way—Single-Way

For accurate control of air and hydraulic cylinders. Provide large volume flow with low pressure drop, easily and quickly regulated. ¼", ⅜" and ½" pipe sizes.

NEEDLE VALVES

Tapered needle provides controlled metering of air, liquids and gases that do not affect brass. Leak-proof. Choice of five types in ⅛" and ¼" pipe sizes.

For complete information, call your nearby Norgren Representative listed in your telephone directory... or

WRITE THE FACTORY FOR NO. 800 CATALOG

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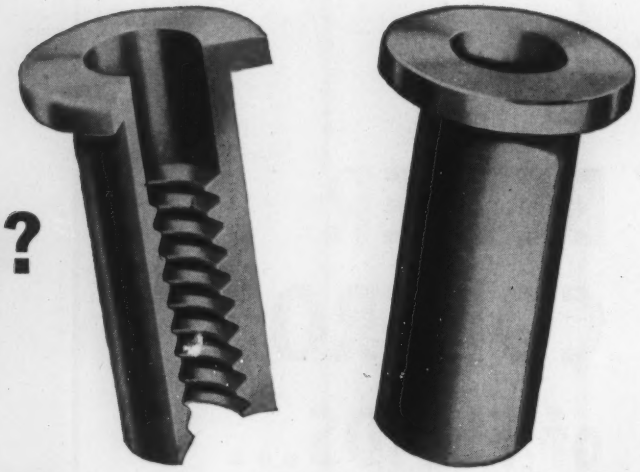
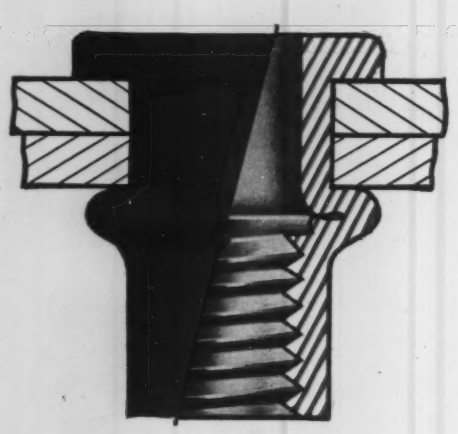
Circle 441 on Page 19

What are they?



B. F. Goodrich Rivnuts®–the only one-piece blind fasteners with threads



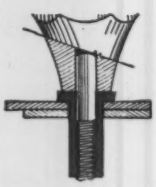
If you have a fastening problem, solve it the easy way—with B. F. Goodrich Rivnuts. One man can install Rivnuts blind from one side of the work. It takes only a few seconds—speeds assembly and cuts costs as much as 50-90% depending upon the applications.

Rivnuts are stronger, too, because they provide at least 6 clean threads, even in thin sheet metal. By eliminating welding, tapping and cleaning, Rivnuts eliminate costly steps in production and straighten out assembly lines.

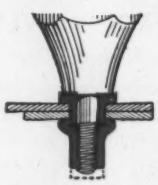
Rivnuts come in a variety of types and sizes and materials to solve your specific fastening problem, in sheet metal, wood, plastic. For complete information, send for the FREE RIVNUT DEMONSTRATOR. It shows with motion how Rivnuts fasten *to* and *with*. B.F.Goodrich Rivnuts, Dept. MD-117, Akron, Ohio.

Rivnuts® provide at least 6 clean threads in one simple operation

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work — tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact ready for screw attachment.

B.F.Goodrich

B.F.Goodrich Aviation Products

a division of The B. F. Goodrich Company, Akron, Ohio

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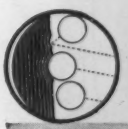

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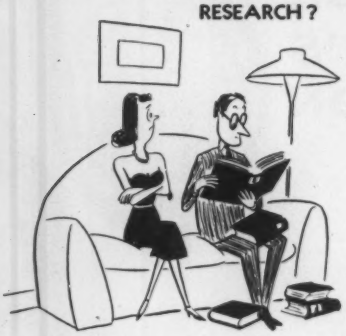
CALCULATIONS CAUSING COMA?

NO TIME FOR RESEARCH?



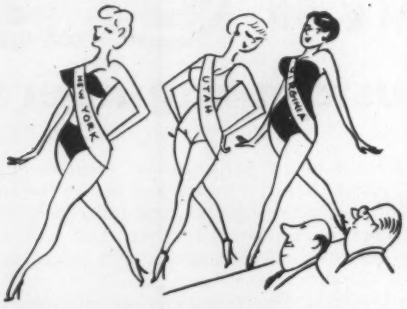
WISH YOU HAD TAKEN UP ANOTHER LINE OF WORK?

find your Spring problem...

NEW PRODUCT APPLICATION?

TRYING TO COIL YOUR OWN SPRINGS?

UP AGAINST SEVERE HEAT CONDITIONS?



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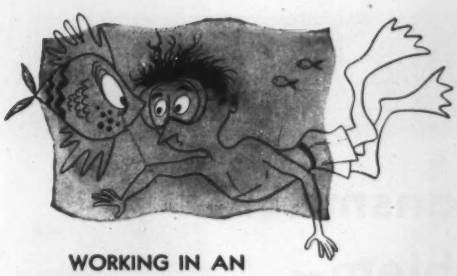
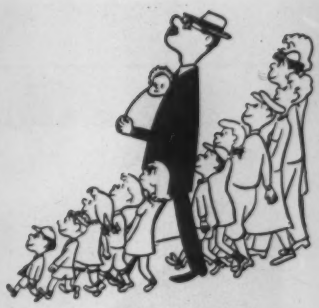
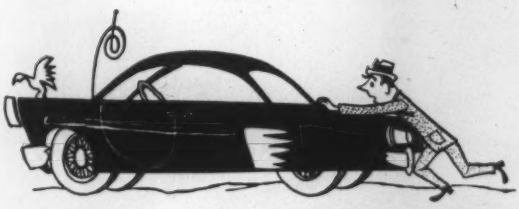


WORKING IN AN UNFAMILIAR ELEMENT?

BECOMING IRRITABLE AT ASSOCIATES?



USING TRIAL-AND-ERROR METHODS?



NEW MODELS CREATING PERFORMANCE PROBLEMS?

NO PROBLEMS? (LUCKY FELLOW)

FIGHTING CORROSIVE CONDITIONS?

HARASSED BY SPACE PROBLEMS?

find the answer here

Send for booklet "Spring Design and Selection—in brief"

Divisions of

ASSOCIATED SPRING CORPORATION

GENERAL OFFICES: BRISTOL, CONNECTICUT

Circle 444 on Page 19

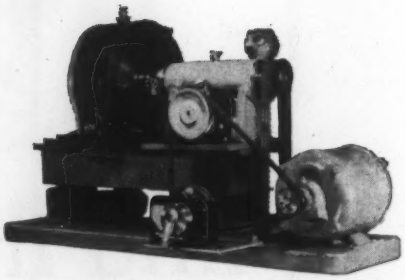
Automatic transmission seal problem—

New National Syntech® proves dependable answer in front pump seal position

Constant temperatures of 250°F, peaks of 300°, continual change in shaft speed, and total inaccessibility of the seal without costly teardown—these are a few of the sealing problems in the front pump of today's automatic transmissions for passenger cars.

To help meet this challenge, National engineers have produced a new oil seal. The new design, a steel encased, spring-loaded unit with Syntech synthetic sealing lip, is characterized by an unusually long flex section in the lip, a special, light-loading tension spring, and the time-tested, low torque Syntech lip itself.

Factory engineers report that the new National seals are proving extremely reliable in the application. Dealers also find the front pump seals are very reliable and do not require early replacement.



To design and thoroughly test the new seal, National engineers developed a new transmission simulator which exactly duplicates front pump operating conditions at all car speeds.

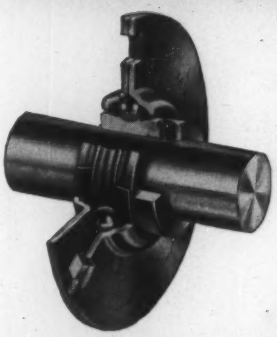
Get real help on seal engineering problems. Call the National Engineer.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

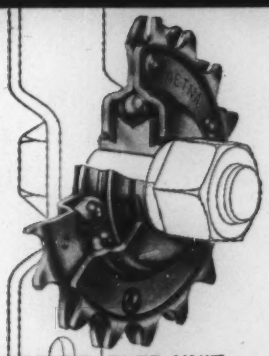
General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

Circle 445 on Page 19

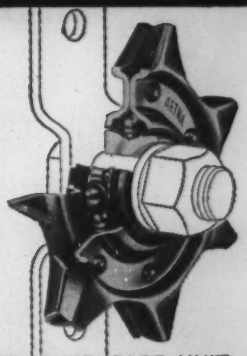
AMERICA'S MOST COMPLETE LINE



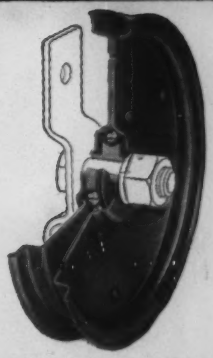
ADAPTER UNIT



SPROCKET IDLER UNIT
(Single pitch chain type)



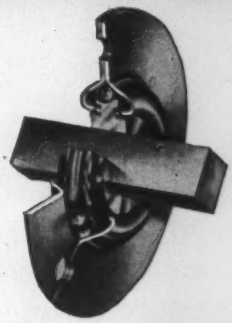
SPROCKET IDLER UNIT
(Detachable link chain type)



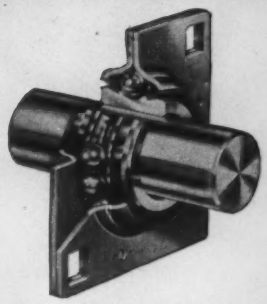
FLAT BELT IDLER UNIT

OF LOW-COST, PRE-LUBRICATED

V-BELT IDLER UNIT



DISC HARROW UNIT



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The Economy Line That Lets You Put MORE Ball Bearing Efficiency to Work in MORE Places

BALL BEARING *Package* UNITS

Designed and built-to-be-installed-and-forgotten these permanently lubricated, sealed-for-life bearing units require no re-lubrication, no maintenance of any kind. Factory assembled, they combine bearing, seals and housing in a single, compact, easy-to-install *package* that saves time on equipment assembly lines—assure longer, trouble-free performance to equipment users.

Catalog AG-57 gives complete specifications. Write for it on your company letterhead—see how, with minimum or no engineering alterations, these inexpensive bearing units can be adapted to your current or projected equipment designs. Aetna Ball and Roller Bearing Company, Division of Parkersburg-Aetna Corporation, 4600 Schubert Avenue, Chicago 39, Illinois.

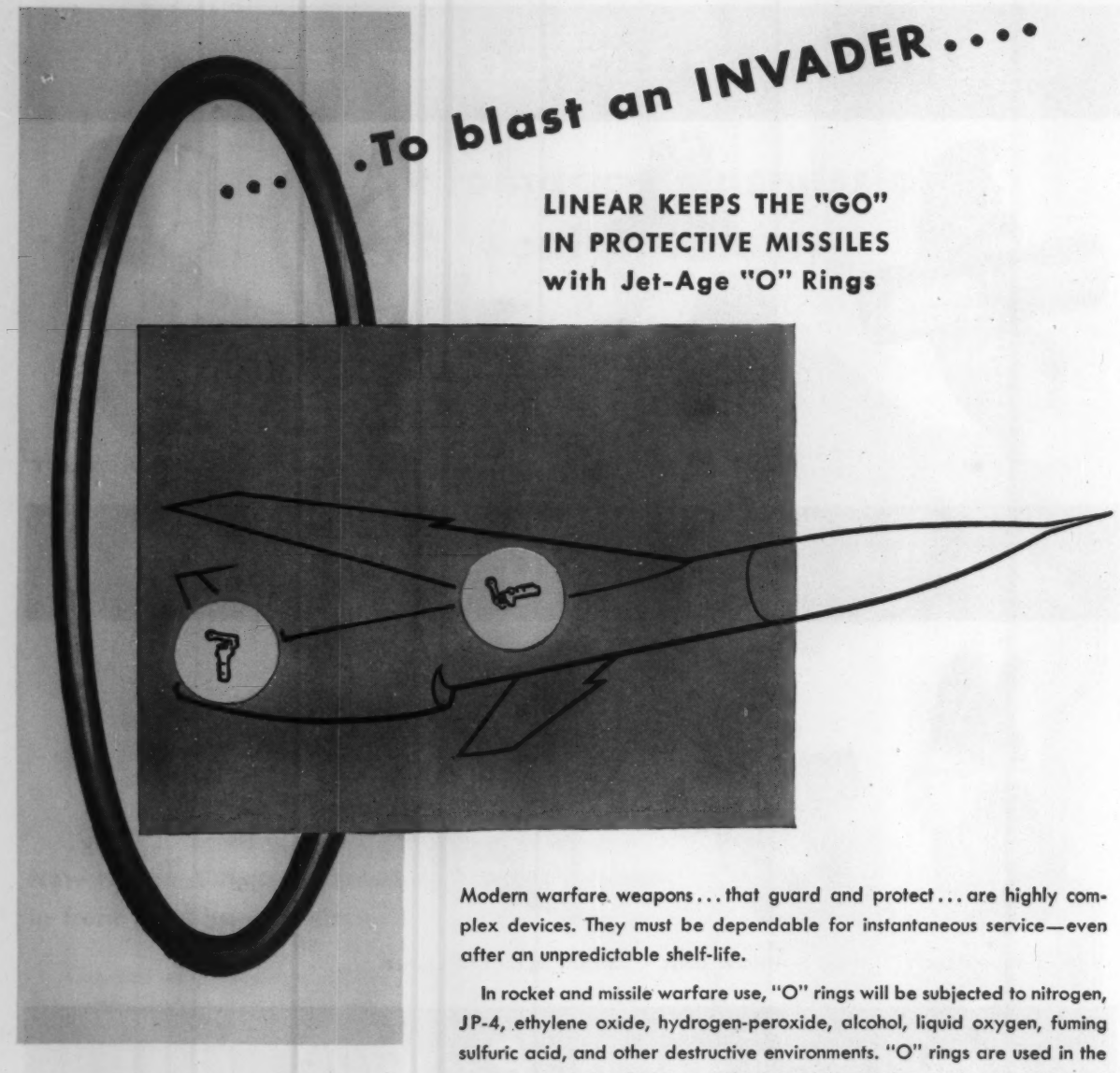
Aetna

Anti-Friction Consultant to Leading Original Equipment Manufacturers Since 1916

Circle 446 on Page 19

. . . To blast an INVADER . . . .

LINEAR KEEPS THE "GO" IN PROTECTIVE MISSILES with Jet-Age "O" Rings



Modern warfare weapons . . . that guard and protect . . . are highly complex devices. They must be dependable for instantaneous service—even after an unpredictable shelf-life.

In rocket and missile warfare use, "O" rings will be subjected to nitrogen, JP-4, ethylene oxide, hydrogen-peroxide, alcohol, liquid oxygen, fuming sulfuric acid, and other destructive environments. "O" rings are used in the servo-systems for flight control of guided missiles, and must withstand extremes in temperatures and the destructive actions of synthetic fluids.

LINEAR'S experience in the design and production of precision "O" rings —of the most modern elastomers—has given them the ability to provide dependable seals for the most critical requirements.

When it's a sealing problem, call on LINEAR or one of its agents for engineering assistance . . .

and be sure to specify LINEAR "O" Rings for prototype or production.

"PERFECTION IN RUBBER"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Circle 447 on Page 19

NOTHING can equal Stainless Steel

in its unique combination of properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. For a reliable source of supply, United States Steel offers you the widest range of types, finishes and sizes. **Just call your steel warehouse.**

For Humid Locations. The Richmond Sifter is made by Sprout-Waldron in Muncy, Pa. Unit shown here has two sets of full-size sieves, containing up to 90 square feet of bolting area. Up to six separations can be made from each of the two sections, and two different materials can be spouted to the sifter. Stainless Steel sieves are supplied when humidity or temperature is high—or when corrosive materials must be sifted. Many sifting applications could not be economically handled without the Stainless Steel sieves.

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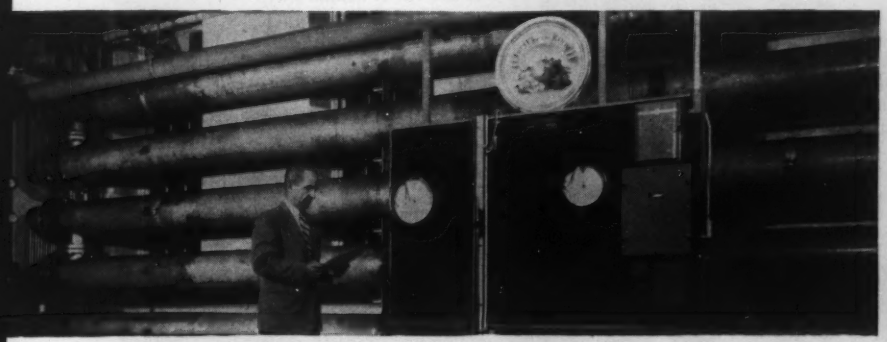
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

For Permanent Beauty. The Santa Fe made news last year when they announced the revolutionary "El Capitan" train. Cars are 15½ feet high, two feet higher than standard, and they are completely sheathed with beautiful Stainless Steel. And in addition to being a glamour metal, Stainless has the corrosion resistance to assure years of gleaming beauty. One Stainless Steel train has been in service over 20 years, and the exterior is still in perfect condition.



For Operating Economy. A textile manufacturer found that they could save about $70,000 **yearly** by using waste hot water to pre-heat the incoming fresh process water. Problem: the hot water had a heavy caustic soda content. Solution was a super-efficiency unit purchased from Ludell Manufacturing Company, in Milwaukee. It is made completely from Type 304 Stainless Steel and contains **19,000** lineal feet of tubing inside the shell units. It is doubtful that any other material could have been used under these conditions. Even better, the unit is expected to last indefinitely.

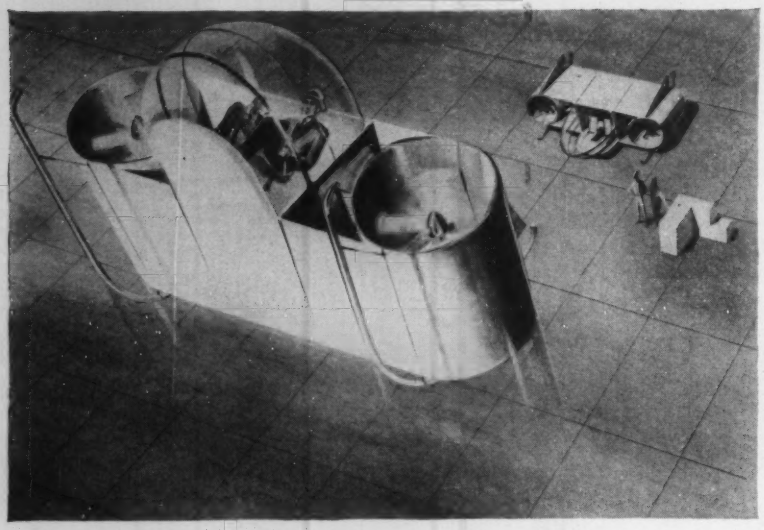
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

Circle 448 on Page 19

MARS outstanding design **SERIES**



rock 'n' fly

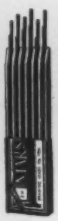
A design combining the aerodynamic principles of ring wings, ducted propulsion and elevons is the novel concept for this all-purpose utility plane that "rocks" on take-off and landing.

Resting on the ground horizontally, the plane is rocked back into vertical take-off position with partial power. It lands the same way, backing down to the ground, then forward to rest. Designer M. A. Novosel of Van Nuys also suggests a unique provision: if one engine fails, an inter-engine shaft is automatically coupled to maintain even thrust. But, most of all, this imaginative "aerial pickup" design embodies economy of operation in both fuel and space.

No one can be sure which of today's design ideas will become production realities tomorrow. But it will be as important then, as it is now, to use the best of tools when pencil and paper translate an idea into a project. And then, as now, there will be no finer tool than Mars – from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and – last but not least – the Mars-Lumochrom, the new color-drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.

The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.



J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY.

at all good engineering and drawing material suppliers

M. A. Novosel, Van Nuys, Calif. designer, one of the winners in the 1957 MARS Contest. Mr. Novosel's project, "Rock 'n' Fly," is featured in the MARS presentation on this page.

MARS announces new design contest

The MARS Outstanding Design Contest of 1957 created such wide interest that MARS Pencils is sponsoring another contest for 1958.

If you are an engineer, architect or student, the MARS contest offers you a "showcase." It provides you with a valuable opportunity to have projects you designed shown in leading magazines where they will be seen by the men in your profession.

You are invited to send in your projects. For every submission that is accepted

MARS pencils will pay you $100

This $100 is paid you simply for the right to reproduce your project in the MARS Outstanding Design Series. There are no strings attached. You will be given full credit. All future rights to the design remain with you. You can reproduce it later wherever you like and sell or dispose of it as you wish.

The subject can be almost anything – aviation, space travel, autos, trains, buildings, engineering structures, household items, tools, machines, business equipment, etc. Projects will be selected on the basis of appeal to design-minded readers, broad interest, attractive presentation. Do not submit a design that is in production. In fact, the project does not need to have been planned for actual execution. It should, however, be either feasible at present or a logical extension of current trends. It cannot be unrealistic or involve purely hypothetical alterations of natural laws.

There is no deadline for entries but the sooner you send yours in, the greater the probability of its selection for the 1958 MARS Outstanding Design Series.

It is Simple To Submit a Design For Mars Outstanding Design Series

Just mail in an inexpensive photostat or photocopy of the subject—one you can spare, since it cannot be returned – and a brief description.

If your entry is accepted, we will ask you to send in a clear photograph or rendering of the design (so that we can make a sharp photograph) suitable for reproduction—after which your material will be returned to you.

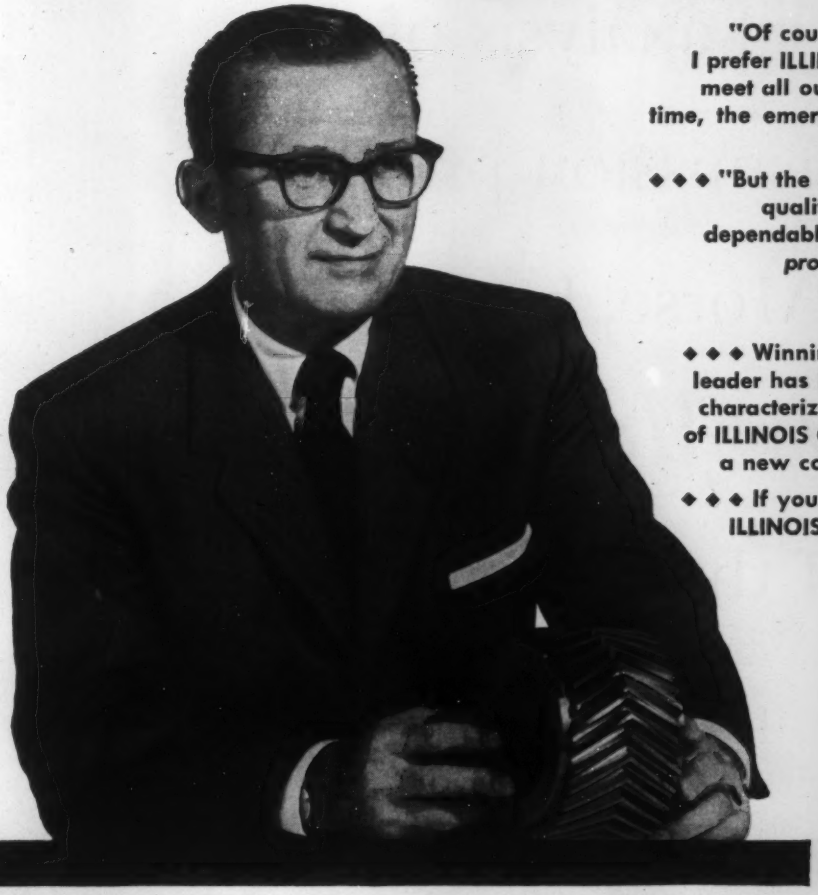
Send your entry to:

J.S. STAEDTLER, INC.
Hackensack, New Jersey

Circle 449 on Page 19

WHY BUY ILLINOIS GEARS?

THE ANSWER IS QUALITY... EVERYTIME!



"Of course, there are many reasons why I prefer ILLINOIS GEARS. I like the way they meet all our specs, the way they deliver on time, the emergency service we get when we need it—to mention a few.

◆ ◆ ◆ "But the one thing I like most of all is the quality of ILLINOIS GEARS—enduring, dependable quality I can trust because it is *proven by performance* . . . one more reason why we feel they are our most economical buy."

◆ ◆ ◆ Winning this recognition as the quality leader has been rightfully earned because it characterizes every step in the manufacture of ILLINOIS GEARS—a creed that established a new concept of quality in gear making.

◆ ◆ ◆ If you are not now using or specifying ILLINOIS GEARS find out about the gears that are *made right with quality as the first consideration.*

Look for this mark (ILL)® *the symbol on finer gears*

Gears for Every Purpose ... one gear or 10,000 or more

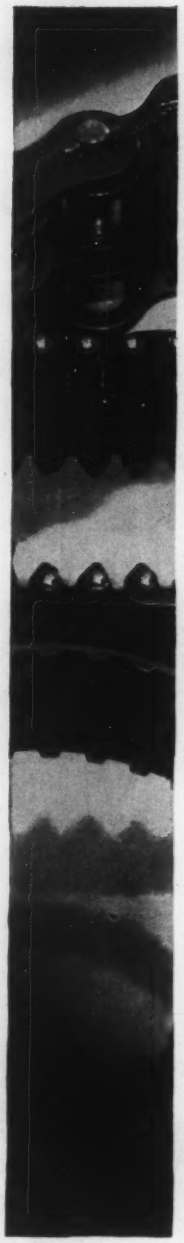
ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

Circle 450 on Page 19

Here's what Morse's entry into the "Timing"® Belt field means to you...

Nobody gives you a more impartial analysis of your power transmission problems than Morse, because . . . *only Morse* offers all four of these basic drives plus a complete line of power transmission products



Basic Drives: Roller Chain, Silent Chain, Hy-Vo Drives and "Timing" Belt.

Chain: H-E, 8-series, Double-Pitch, Implement, and Attachment; AL, BL, and Rollerless Lift Chain; Industrial Standard and 3/16″-pitch Silent Chain.

Stock Sprockets: Plain Bore, Finished Bore, Taper-Lock—also made to order.

Couplings: Flexible Roller Chain Couplings, Flexible Silent Chain Couplings, Morflex Couplings, Morflex Radial Couplings, Marine Couplings.

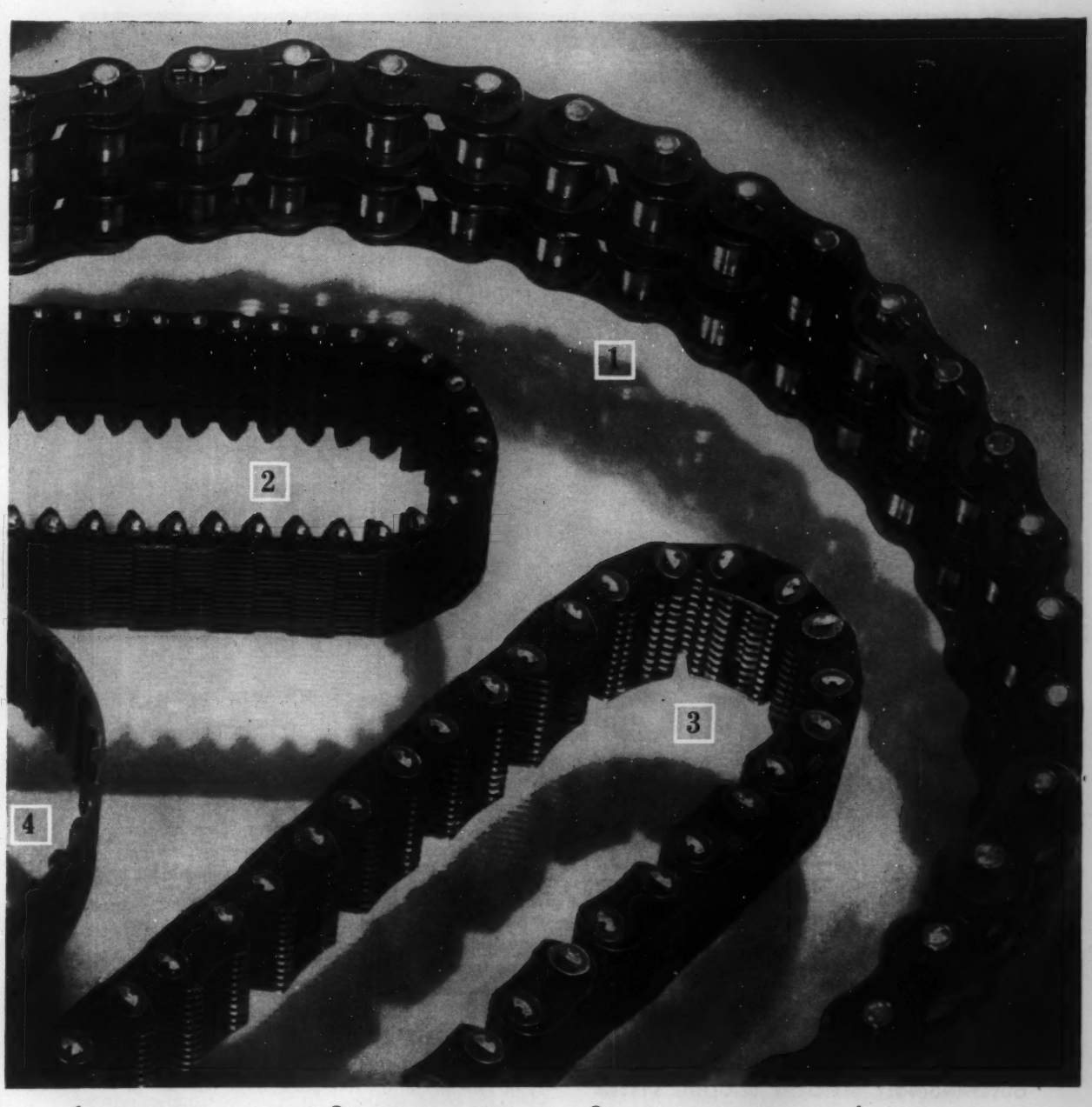
Driveshafts: Morflex and Radial Driveshafts.

Clutches: Overrunning Clutches; Over-Center Clutches.

Speed Reducers: Eberhardt-Denver "RW" poweR-gear® Reducers; Gearmotors; "L" Worm Gear Reducers; "VX" and "DVX" Conveyor Drives; Miter Boxes; Helical Reducers.

Torque Limiters.

Look for your local Morse distributor in the Yellow Pages under "Power Transmission," or write: *MORSE CHAIN COMPANY, DEPT. 6-117, ITHACA, NEW YORK; Export Sales: Borg-Warner International, Chicago 3, Illinois.*



1. **Roller Chain** . . . for low and medium speed applications. Precision-finished Morse Roller Chain is specially treated to withstand shock and fatigue, assure less maintenance, longer service life. Patented Spirol Pin Fastener construction.

2. **Silent Chain** . . . for smoother, quieter operation at higher speeds. In Morse Silent Chain the patented rocker joint operates with less friction and wear. It provides a cooler-running chain drive, with higher efficiency and longer service life.

3. **Hy-Vo Drive** . . . for extremely high speeds and horsepower. Exclusive with Morse, extra-tough Hy-Vo Drives transmit mile-a-minute speeds, and up to 5,000 hp loads; require minimum shaft space, usually eliminate outboard bearings.

4. **"Timing" Belt** . . . for light weight and lubrication-free operation. Morse "Timing" Belts give positive, high-efficiency transmission from 0 to 16,000 FPM, 1/100 HP to 1,000 HP . . . provide slip- and stretch-proof service for life of drive.

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

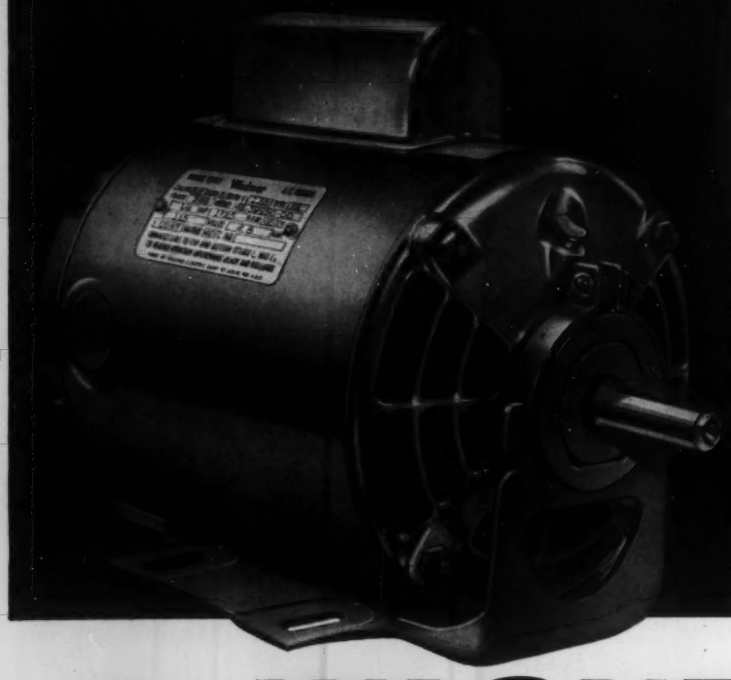
MORSE

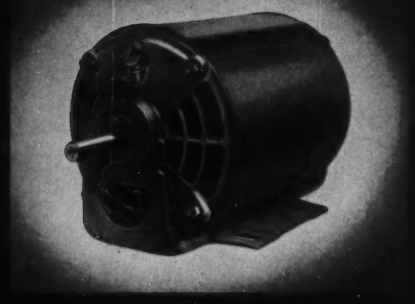
MORSE B-W BORG-WARNER

*Trademark

Circle 451 on Page 19

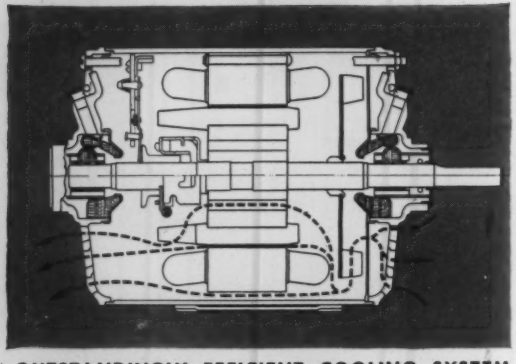
DESIGN ENGINEERS!





This compact, cool-running fhp motor saves space and weight... mounts at any angle

the WAGNER "48"



OUTSTANDINGLY EFFICIENT COOLING SYSTEM

Schematic drawing shows how a large volume of air is directed through the motor to effectively reduce temperatures. Large blower at right draws air in through drip-proof openings in back endplate, forces it around back coil extension—through rotor vent holes—air gap—and through passages between stator core and frame. Cast blower at left circulates air around coil extension and drives it out the motor through front endplate openings.

Savings in space and weight are among the many advantages of using Wagner "48" capacitor-start or split-phase motors in your equipment. These motors come in the standard 48 frame sizes and weigh from 3 to 8 pounds less than the previous models in the same hp ratings.

Because no parts of the motor mechanism are housed in the endplates, it is possible to materially reduce their depth. An effective lubrication system assures positive protective lubrication for the bearings in any position. You can mount these motors at the angle best suited to your equipment.

The capacitor-start, Type RK "48" comes in 1/6 or 1/4 hp ratings, and the split-phase, Type RB "48" in 1/6, 1/4 or 1/3 hp. Both types are available with resilient bases or with rigid bases that are welded to the steel motor frames for ruggedness and strength. You can get these motors from leading motor distributors in your community and from Wagner sales offices in 32 principal cities. Check your telephone directory for the supplier nearest you. Write for your file copy of NEW Bulletin MU-217 on the Wagner "48".

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

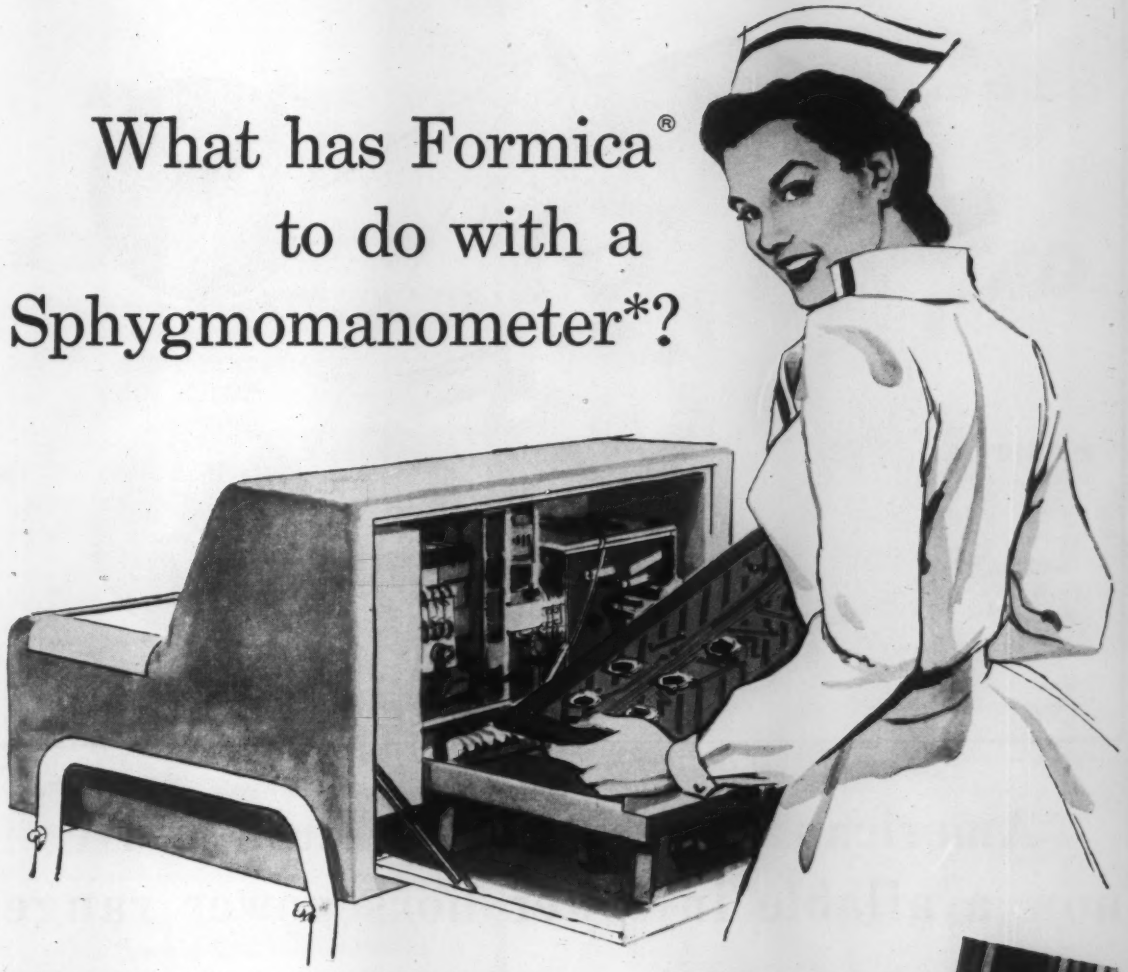
H57-13

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6404 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

What has Formica® to do with a Sphygmomanometer*?



This sphygmomanometer* – or automatic blood pressure recorder, if you prefer – demonstrates how Formica XXXP-36 copper clad laminated plastics is being used in a versatile printed circuit application.

In this case, a printed circuit provides the absolute interchangeability of parts in the field which simplifies and reduces the cost of field service on complicated electronic products.

The application versatility of Formica XXXP-36 then can be applied to many different kinds of electrical and electronic applications. You'll benefit especially from Formica-4 – the complete laminated plastics service that cuts engineering time, reduces component parts costs and assures delivery schedules for mass production operation.

FORMICA
CYANAMID

FI-1543

(1) Application Engineering
(2) Research
(3) Fabricating
(4) Customer stock service

Complete information on how Formica Laminated Plastics serves product designers in every field is contained in this 20-page Technical Catalog. Send for your free copy.

Formica Corporation
4514-7 Spring Grove Ave. Cincinnati 32, Ohio

Please send me a free copy of Formica Technical Catalog form 627.

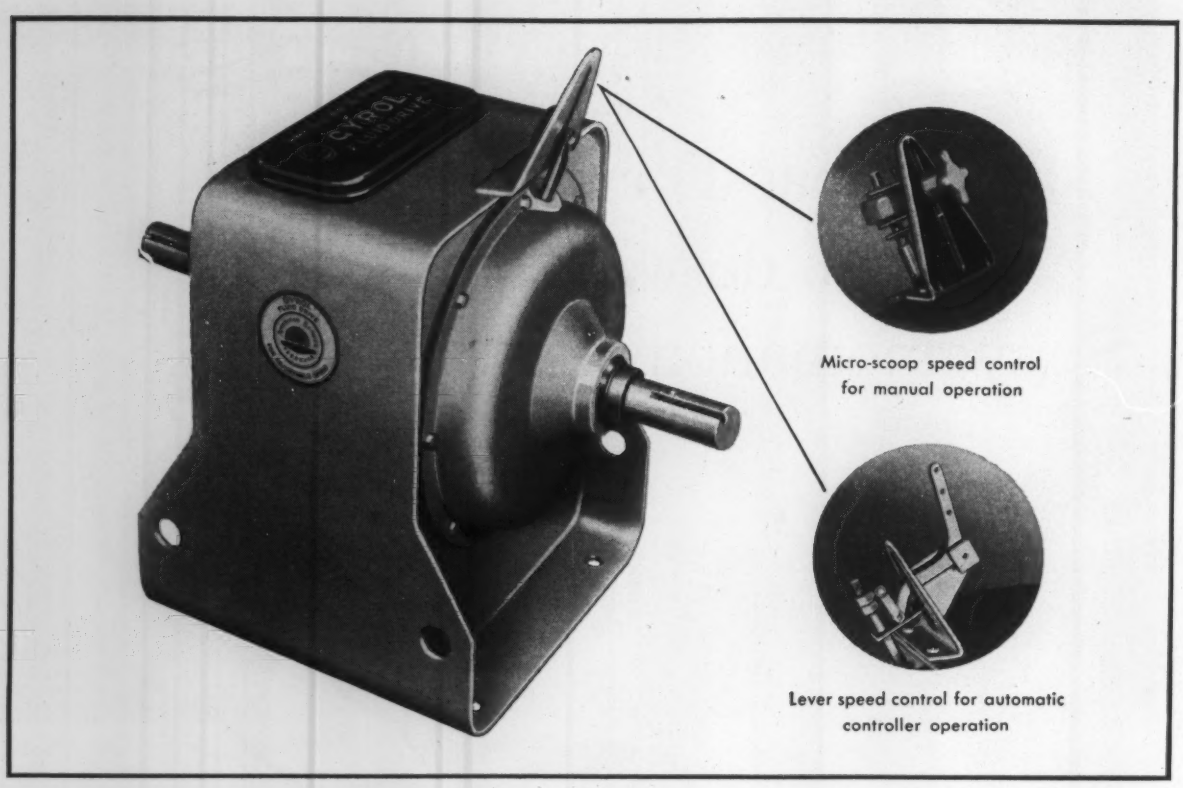
Name_____

Company_____

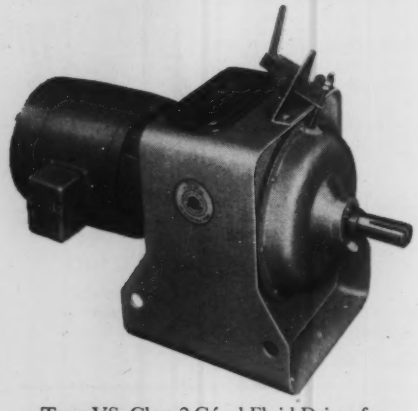
Title_____

Address_____

City_____ Zone_____ State_____



American Blower *Gýrol*® Fluid Drives now available in lower horsepower ranges!



Type VS, Class 2 Gýrol Fluid Drives for 1- to 25-hp applications. Also available with flange-mounted motor, as shown.

Adaptable to either automatic or manual control, American Blower Type VS, Class 2 Gýrol Fluid Drives come in a complete range of new smaller sizes—1 hp to 25 hp, speeds to 3600 rpm—to satisfy your every power-transmission need!

These compact, self-contained units offer an answer to many industrial-drive problems because of their important benefits: adjustable, stepless speed control; full reversibility; 5 to 1 speed range; no-load starting; protection against shock; quiet operation.

For full information on the complete line of Type VS, Class 2 Gýrol Fluid Drives, 1-800 hp—or other designs to 12,000 hp—contact our nearest branch office. Or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of AMERICAN-Standard

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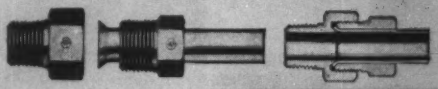
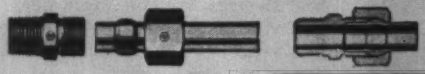
Best for your product, too!

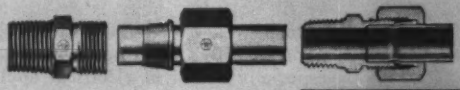
SAE 45° FLARE



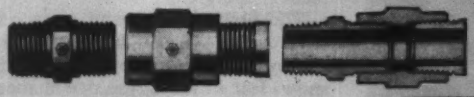
INVERTED FLARE



COMPRESSION



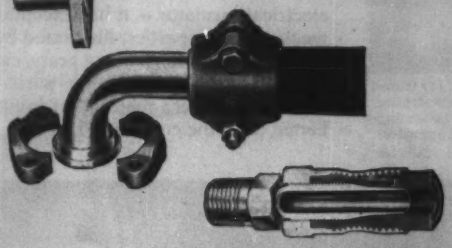
SELFALIGN



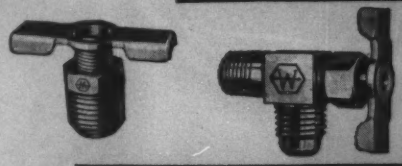
PIPE

CRIMPED

HOSE ASSEMBLIES



REUSABLE HOSE ENDS

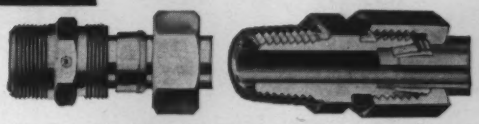


DRAIN AND SHUTOFF COCKS

WEATHERHEAD

EVERY COMPONENT TO MEET ANY HYDRAULIC REQUIREMENT

ERMETO



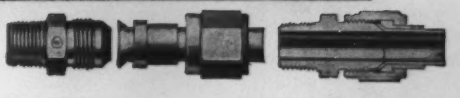
Steel and stainless steel Ermeto fittings in sizes and types to meet any need. No flaring, threading, welding or soldering.

STRAIGHT-THREAD ERMETO

Straight-thread Ermeto meets new S.A.E. Boss specifications. Closer coupling; higher PSI without backup rings. New "Weathercote" finish for greater corrosion resistance.

S.A.E. 37° FLARE-TWIN (J.I.C.)

3-PIECE



2-PIECE

37° flared fittings available with standard-thread or with new straight-thread in popular styles and sizes for S.A.E. O-ring design boss. Withstands higher pressures without backup rings. Easier assembly, closer coupling. Corrosion-resistant "weathercote" finish.

NFPA

WEATHERHEAD

FIRST IN HYDRAULIC CONNECTIONS

THE WEATHERHEAD CO., FORT WAYNE DIVISION

Dept. AB-11, 128 West Washington Blvd., Fort Wayne, Indiana

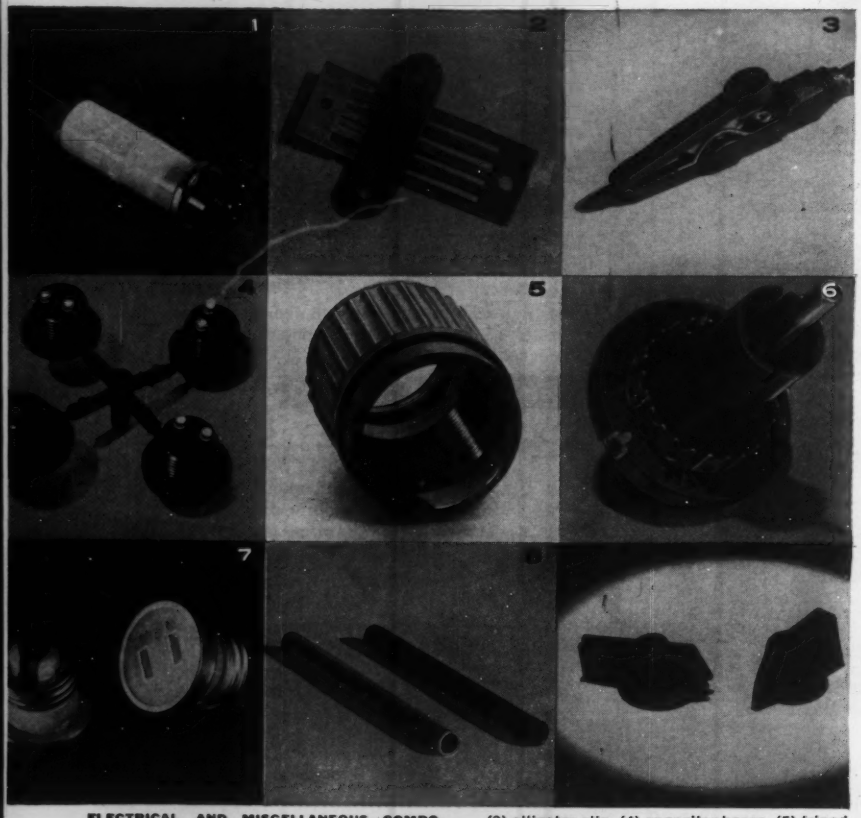
In Canada: The Weatherhead Co., Ltd., St. Thomas, Ontario

DU PONT

PRODUCT

LATEST PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS

Du Pont ZYTEL® nylon resin makes fabrication of electrical parts easier... improves performance



ELECTRICAL AND MISCELLANEOUS COMPONENTS molded of ZYTEL nylon resin are exceptionally sturdy and reliable in operation. (1) pilot light with body of ZYTEL and lens of Du Pont LUCITE®, (2) multiple-switch part, (3) alligator clip, (4) capacitor bases, (5) tripod leg lock, (6) switch assembly, (7) socket plug, (8) test prod sleeves, (9) bar knobs. (Manufactured by Industrial Devices, Inc., Edgewater, New Jersey.)

Stronger, better component parts often result when designers specify ZYTEL nylon resin. Shown here are a series of components manufactured by Industrial Devices, Inc., of Edgewater, New Jersey, which utilize ZYTEL nylon resin in a variety of ways. Each part utilizes one or more of the useful properties of this Du Pont engineering material.

ZYTEL nylon resin is a thermoplastic, yet its softening point is so high that parts molded from it are rated for operation to 250°F. This heat resistance is especially useful in electrical applications, where a rise in temperature in critical parts occurs when the equipment is operated.

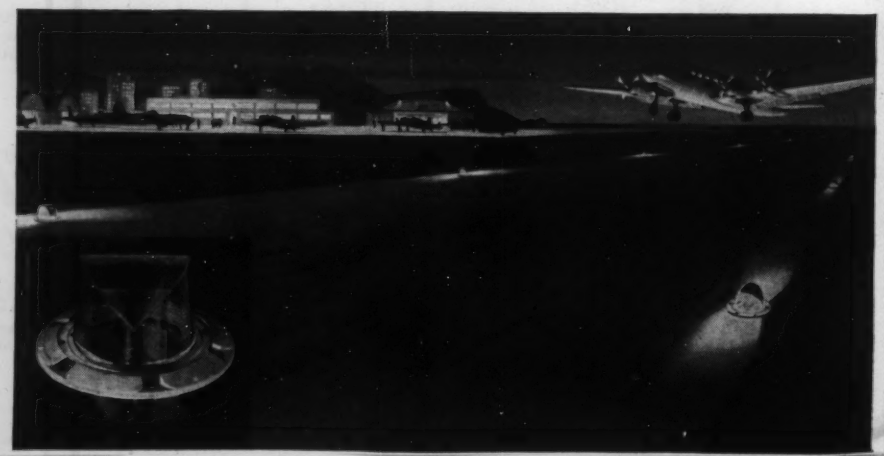
The high strength and wear resistance of ZYTEL give added scope to the design engineer, as the examples at left show. For instance, the detent mechanism of switch (6) is molded as part of the assembly and is extremely resistant to wear. The bar knobs (9) need no insert because the molding itself meets all strength and torque requirements. The toughness of ZYTEL is demonstrated by its use as jacketing on infantry field telephone wire, which is often laid directly on the ground and subjected to the roughest treatment in combat.

ZYTEL nylon resin is not only a good electrical insulator — it has exceptional mechanical properties, illustrated by its widespread use for making gears, cams, bearings and other machine parts. To know this modern material of industry better, send the coupon today.

Runway light has dome of rugged, optically efficient Du Pont LUCITE®

A new runway marker light developed by the Stimsonite Division, Elastic Stop Nut Corporation, Chicago, Illinois, utilizes a dome molded of durable LUCITE acrylic resin, which permits light-source and reflectors to be placed below level of runway.

The dome houses reflectors, and is optically contoured to produce the required light divergence. LUCITE retains its excellent optical properties despite weather and is unaffected by operating temperatures.



ENGINEERING NEWS

ZYTEL®, TEFLON®, LUCITE®

Frictional welding technique joins plastic parts

SPIN WELDING is a technique for joining rotationally symmetric parts, investigated and further developed by Du Pont's Sales Service Laboratory. Spin welding is especially useful with thermoplastics such as Du Pont ZYTEL nylon resin, LUCITE acrylic resin, and ALATHON polyethylene resin. One part is held stationary while the other rubs against it under light pressure until an adequate melt is obtained from the frictional heat. The stationary part is then released and turns with the rotating part under pressure. Junctures are as strong as the original material.

Du Pont Polychemicals Sales Service Laboratory expands

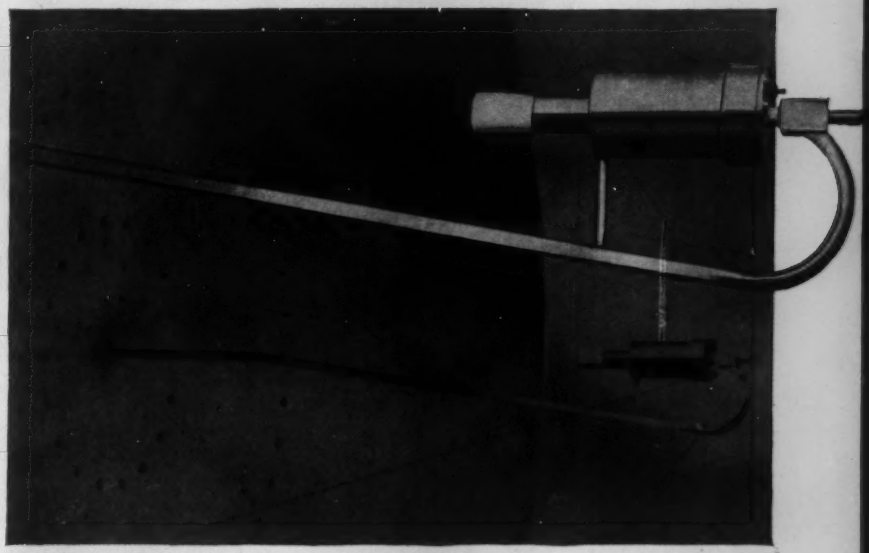
Additional space for the development of plastics processing and design techniques will soon be under construction at Chestnut Run, near Wilmington, Delaware. The expansion will help to speed evaluation of various plastics under working conditions, and to increase the scope of technical service rendered to customers.

Development work with new products will include the materials TEFLON 100-X perfluorocarbon resin, a plastic with outstanding heat and chemical resistance that can be fabricated in conventional equipment, and Delrin acetal resin, a new plastic material with an ability to retain its mechanical properties over wide variations of temperature and humidity.

Circle 456 on Page 19

Impedance matching and weather protection of Du Pont TEFLON® featured in new radar antenna

tetrafluoroethylene resins



RADOME of a TEFLON resin matches impedance of feedhorn to space and provides protection against weather. Waveguide impedances at input and output of ferromagnetic rotator in the feed are matched with minimum insertion loss by internal cones of a TEFLON resin. (Made by Diamond Antenna and Microwave Corporation, Wakefield, Massachusetts.)

Du Pont TEFLON, tetrafluoroethylene resins are uniquely qualified as materials for making the matching devices and radome used in the feed system of a new variable-polarization K-band antenna. The 16,000 mc radar signal passes through an impedance-matching and weatherizing system based on components of a TEFLON resin, and is reflected from the accurate parabolic dish. The .027" wall of the radome matches the horn to space.

No other materials could compare with TEFLON resins for this highly critical electronic application. They are unaffected by outdoor weathering and have so little moisture absorption that their dielectric constant remains unchanged under all humidity conditions. The very low dielectric constant of TEFLON resins gives the material its excellent matching characteristics. Use of TEFLON resins permits a very low loss figure in transmission at these superhigh frequencies. Dirt has no tendency to stick to the naturally "slick" surface, and TEFLON resins are unaffected by heating to 260°C.

* * *

For your own designs, you are invited to take a closer look at the many outstanding advantages of TEFLON resins. The coupon will bring you details.

SEND FOR INFORMATION

For additional property and application data on LUCITE® acrylic resin, TEFLON® fluorocarbon resins and ZYTEL® nylon resin, mail coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 1414, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ ZYTEL; ☐ TEFLON; ☐ LUCITE.
I am interested in evaluating these materials for:

*Name*_____

*Company*_____ *Position*_____

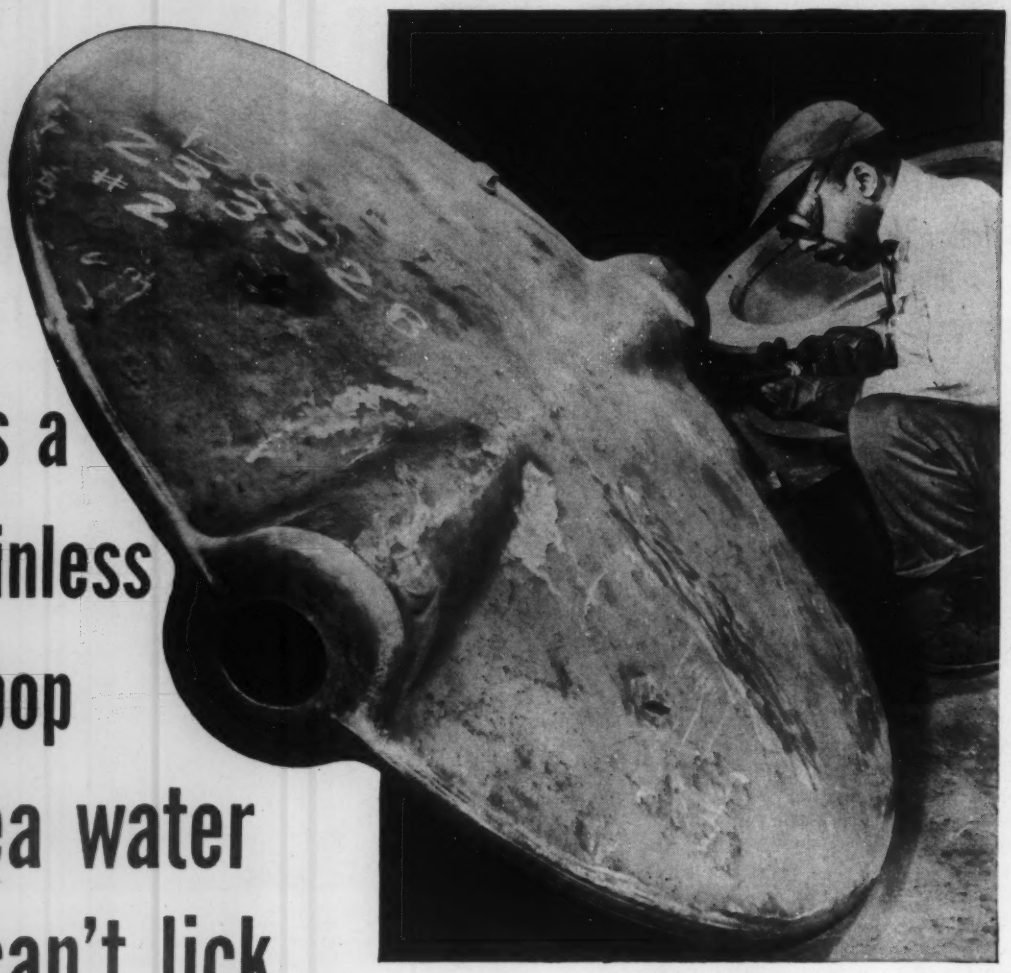
*Street*_____

*City*_____ *State*_____

*Type of Business*_____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec

Here's a stainless lollipop sea water can't lick



This large (48″ dia., 1701 lbs.) and unusual stainless casting was fabricated by Allegheny Ludlum's Buffalo, N.Y. foundry. It is scheduled for service under the most severe operating conditions, functioning as a wafer valve disc at 25 psi pressure in sea water. Since long life and tight closing are essential in this application, corrosion resistant Type 304 Allegheny Stainless was specified.

Some unusual techniques were employed in the fabrication of this casting. Although the entire valve disc was cast as a single piece, its sides are hollow, with a skin only ¾″ thick. The center shaft was cast solid at the same time the side wings were cored, permitting the single piece, seamless part desired.

If you have a casting problem, or *any* problem that involves corrosion resistance, long life, resistance to wear and abrasion, call the Allegheny Ludlum Sales Office nearest you. An A-L Sales Engineer is ready to put his skills and those of the A-L Technical Staff promptly at your disposal, to serve your requirements from the largest and most complete line of stainless products on the market.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.

WSW 6663

Write for this 28-page booklet on A-L STAINLESS CASTINGS

28 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

ADDRESS DEPT. MD-95

Make it BETTER and LONGER LASTING with

ALLEGHENY STAINLESS

Warehouse stocks carried by all Ryerson steel plants

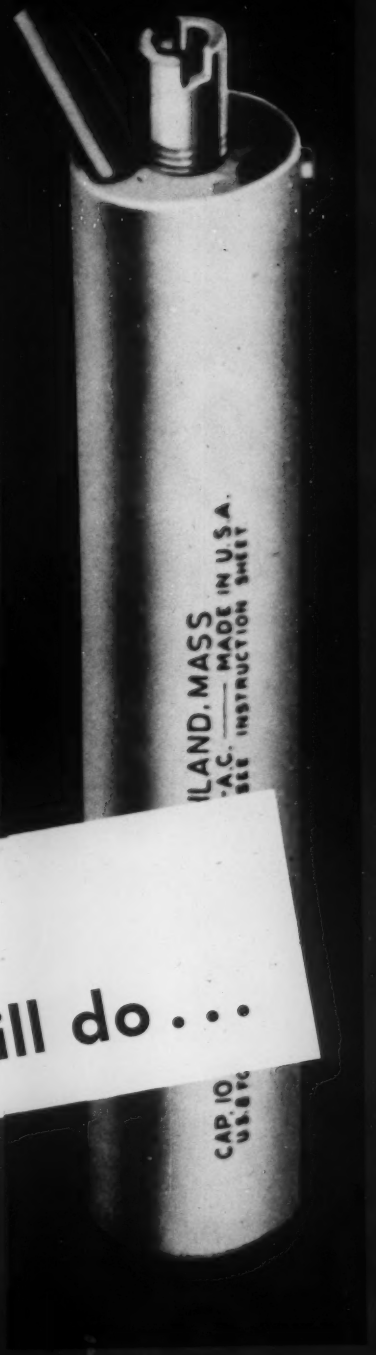
AL

Circle 457 on Page 19

Circle 458 on Page 19→

Got a temperature control problem?

Fenwal

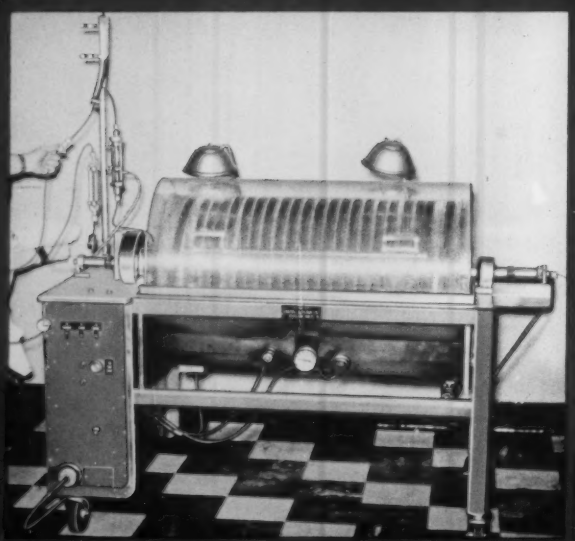


Tell you what a THERMOSWITCH® unit will do . . .

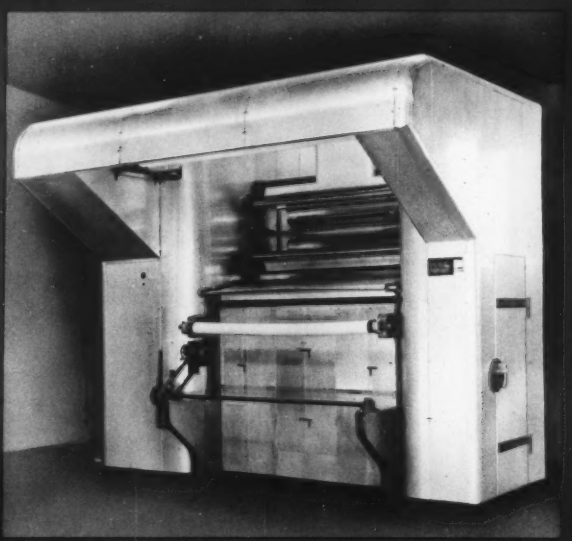
With Fenwal THERMOSWITCH® Units YOUR EQUIPMENT WILL...

- **Run at Faster Speeds** with increased output because of more precise temperature control. The inherent sensitivity of a Fenwal THERMOSWITCH unit is 1/10 of one degree Fahrenheit. Enjoy this competitive advantage!
- **Require Less Maintenance.** A Fenwal THERMOSWITCH unit has ten times as much resistance to vibration as ordinary thermostats. It has military ruggedness to resist shock to 100 G's. And it's tamper-proof!
- **Have Increased Flexibility.** Fenwal THERMOSWITCH units have a range of 700° F... three to five times that of ordinary thermostats. Open up new markets with this feature!
- **Have Longer Life.** Fenwal THERMOSWITCH units consistently provide one-half million or more cycles of precision temperature control. Cost is surprisingly low... not more than 2¢ per thousand cycles.
- **Have Reduced Assembly Costs.** All Fenwal THERMOSWITCH units fit a ⅝" hole, the cheapest machining operation. They're the same size as standard cartridge heaters!

for example...



The Kolff-Brigham Artificial Kidney



The National Heat Setting Machine for synthetic woven fabrics

From Delicate Medical Equipment to Rugged Production Machinery

Fenwal THERMOSWITCH units are being used in countless applications.

Here's why Fenwal THERMOSWITCH® units provide such advantages

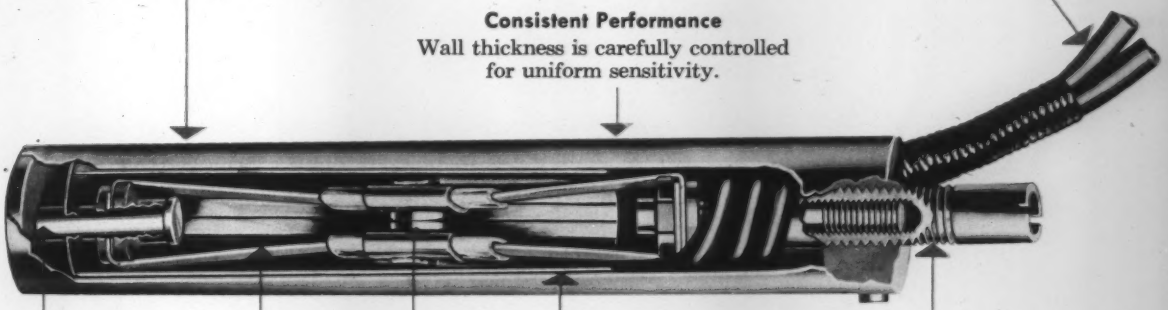
The activating control element is a single-metal shell that expands or contracts instantaneously with temperature change, making or breaking the totally-enclosed electrical contacts. The shell is the temperature-sensing element. There are no heat transfer paths as in ordinary thermostats.

SERIES 17000 BASIC DESIGN*

Maximum Dielectric Strength
Lead wires are Teflon-wrapped.

Easy Installation
All shells fit a 5/8″ (.0625″) reamed hole.

Consistent Performance
Wall thickness is carefully controlled for uniform sensitivity.



Shock and Vibration Resistant*
Struts are in tension or compression.

UL and CSA Listed*
Creep distances in accordance with standards of either group.

No Undershoot or Overshoot Problems*
Anchor pin has parting joint.

Field Adjustable
Simple — with a compound screw thread for fine adjustment.

Maximum Life and Control Accuracy
Specially designed fine silver contacts.

*TENSION TYPE ILLUSTRATED

Way ahead of ORDINARY THERMOSTATS
Only FENWAL THERMOSWITCH® units offer . . .

- **Quick Reaction** — four to nine times as fast
- **Narrow Temperature Differential** — one-twelfth to one-eighteenth as great
- **Vibration Resistance** — one-tenth to one-eighteenth as much shock-sensitivity
- **Uniform Sensitivity** — throughout the operating range

Name your problem!

Chances are we can name a Fenwal THERMOSWITCH® unit to solve it!

There's a Fenwal sales engineer ready to apply one of 25000 THERMOSWITCH unit variations to your particular heat control problem. Here are just a few . . .

STANDARD TYPE

SERIES 17000
CARTRIDGE
THERMOSWITCH CONTROL

Easily inserted in reamed hole in metal blocks and other solids.

EXPERIMENTAL TYPE

SERIES 17500
ALL-PURPOSE
THERMOSWITCH CONTROL

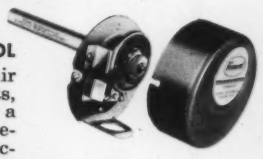
Generally used for experimental and laboratory work. Its wide temperature range (−100 to 600° F) makes it useful in a wide variety of test work.

FLUID IMMERSION TYPE

SERIES 17100
HEX HEAD
THERMOSWITCH CONTROL

Easily inserted directly into fluid by mounting in a tapped hole in container wall.

AIR CONTROL TYPE



SERIES 17700
JUNCTION BOX AIR
THERMOSWITCH CONTROL

Ideal for the control of air temperatures in air ducts, ovens, driers, etc., where a conduit junction box is required to facilitate electrical wiring. Available for fluid immersion also.

SURFACE MOUNTING TYPE

SERIES 17300
FLANGE HEAD
THERMOSWITCH CONTROL

The three tapped holes allow this unit to be mounted against any flat surface with proper size screws. A dial and knob as well as flexible lead wires can be attached.

CLOSED SYSTEM TYPE

SERIES 18000
COUPLING HEAD
THERMOSWITCH CONTROL

Generally used in closed liquid or gas systems by direct insertion in the medium to be controlled.

Write for a free booklet (MC-135) containing complete specifications on Fenwal THERMOSWITCH units.

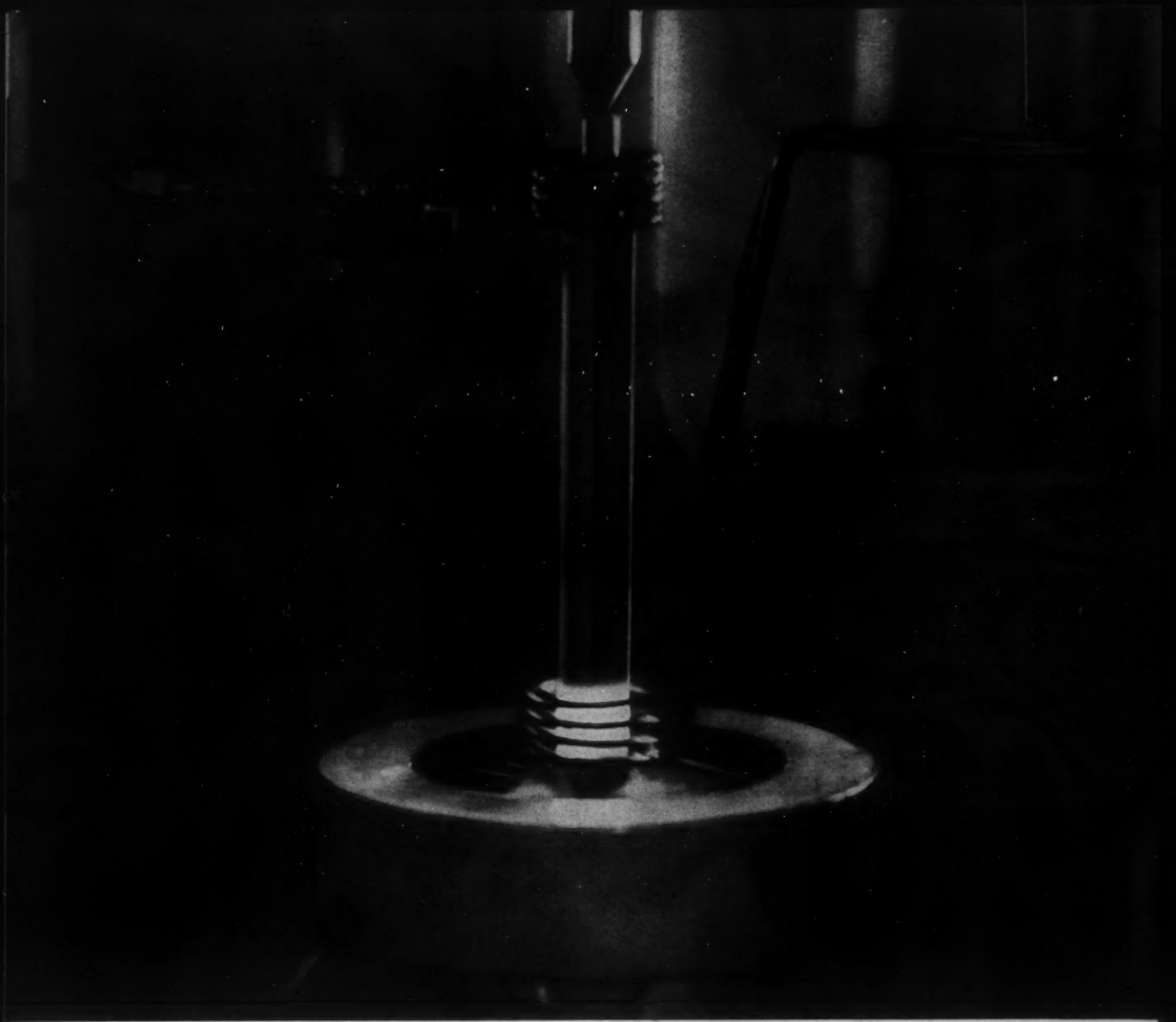
Fenwal

INCORPORATED

9-57 MC157 Printed in U.S.A.

1912 Pleasant Street Ashland, Massachusetts

CONTROLS TEMPERATURE . . . PRECISELY



Ketos shaft being induction hardened to Rockwell 55-56, while ends remain soft for final machining. Photographed at Control Instrument Co., Inc., Brooklyn, N. Y.

KETOS has wide hardening range with minimum volume change...

Ketos is a low priced alloy tool steel that can be hardened from low temperatures with practically no volume change. It has deep hardening qualities, and a fine grained structure, that make it desirable for many production parts.

That's why nondeforming Ketos is well suited not only for most tool steel applications such as gauges, dies, and taps but also for close-tolerance, wear-resistant parts like the actuator bar shown in the induction heating unit above. The thin contact edges of this particular part withstood a "life test" of over 4-million high speed blows. No other steel tested lasted more than 1-million cycles before it chipped and failed.

If Ketos sounds like the steel you should be using, call your nearby Crucible warehouse. Stocks of Ketos and dozens of other special tool steels are large, delivery fast. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

Circle 459 on Page 19

Blind assembly costs cut in half with SPEED GRIP® Bolt and Nut Retainers

A tip-in . . . a sidewise pull . . . and this new front-mounting SPEED GRIP Bolt and Nut Retainer is locked in the panel without special tools or skills.

The exclusive SPEED GRIP locking feature provides enough lateral drift to compensate for normal production misalignment of the parts to be fastened together.

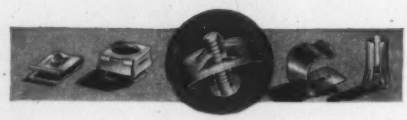
Blind-panel assemblies no longer require awkward, time-consuming acrobatics for fastening. The problems caused by damaged threads in welded, staked, or clinched fasteners are eliminated. SPEED GRIPS can be slipped into place anywhere on the production line.

These convenient, time-saving SPEED GRIPS are available to fasten a wide range of unit sizes and bolt diameters to a variety of panel thicknesses. Ask your Tinnerman representative for samples and engineering data. All major telephone directories list your closest Tinnerman Sales Engineer. Or write to

TINNERMAN PRODUCTS, INC.
P.O. Box 6688 • Dept. 12 • Cleveland 1, Ohio

TINNERMAN

Speed Nuts®



FASTEST THING IN FASTENINGS®

NEW–*The Most Universal Valve Packing Ever Developed!*

New Garlock 5022 is the nearest thing to a universal valve stem packing. Its many advantages far outweigh its slightly higher cost. Made of asbestos and TEFLON* pressed into a dense die formed ring, the new packing stands up against steam, water, mild acids, alkalies, and solvents. It is clean, cannot contaminate or discolor the product handled. It contains no graphite or lubricant; the TEFLON acts as an excellent lubricant yet does not exude, dry out, or burn out. Withstands temperatures to 500° F. Ideal for original equipment such as valves, faucets, appliances, etc.

Garlock 5022 and the other Garlock Molded Valve Rings listed at right are available specifically for production line use where accurately sized packings are required for high speed assembly. They are furnished in quantities of 500 and over, in many standard sizes or to your exact specifications.

Molded Valve Rings are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The *only* complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for Valve Ring Data.

OTHER GARLOCK VALVE RINGS

Garlock 160 Rings for use against steam at temperatures to 600° F.

Garlock 161 Rings for use against cold water and alcohol.

Garlock 162 Rings for use against cold oil, gasoline, benzol, chlorinated solvents, etc.

Garlock 163 Rings for use against high and low pressure steam, water, alcohol and some aqueous solutions.

Garlock 166 Rings for use against steam or gases to 600° F. hot or cold water, oils and solvents.

THE GARLOCK PACKING COMPANY, Palmyra, New York

*DuPont Company Trade Mark

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

Circle 461 on Page 19

The exciting new material to complement

REYNOLDS ALUMINUM TUBED SHEET

one-side-flat

(patent pending)

Reynolds Tubed Sheet One-Side-Flat is the only sheet now in production with one flat side providing integral tubing in any parallel or non-parallel patterns no matter how complex! Tubed Sheet *One-Side-Flat* (two sheets of aluminum metallurgically bonded together so that the heat transfer passageways are *in the sheet*) is flat on one side and has the built-in tubing pattern on the other side. This amazing material routes gas or liquid wherever needed with greater freedom and greater efficiency and at lower costs.

Some of the benefits of Tubed Sheet *One-Side-Flat* are currently demonstrated in refrigerator evaporators. Re-designs are simplified, can be made quicker and at lower cost. Metal formerly required for evaporator tubing, accumulators and receivers is not needed. Many connecting and assembling operations are eliminated. Tubed Sheet can be embossed in a decorative pattern or left smooth. It also can be color anodized in most colors desired.

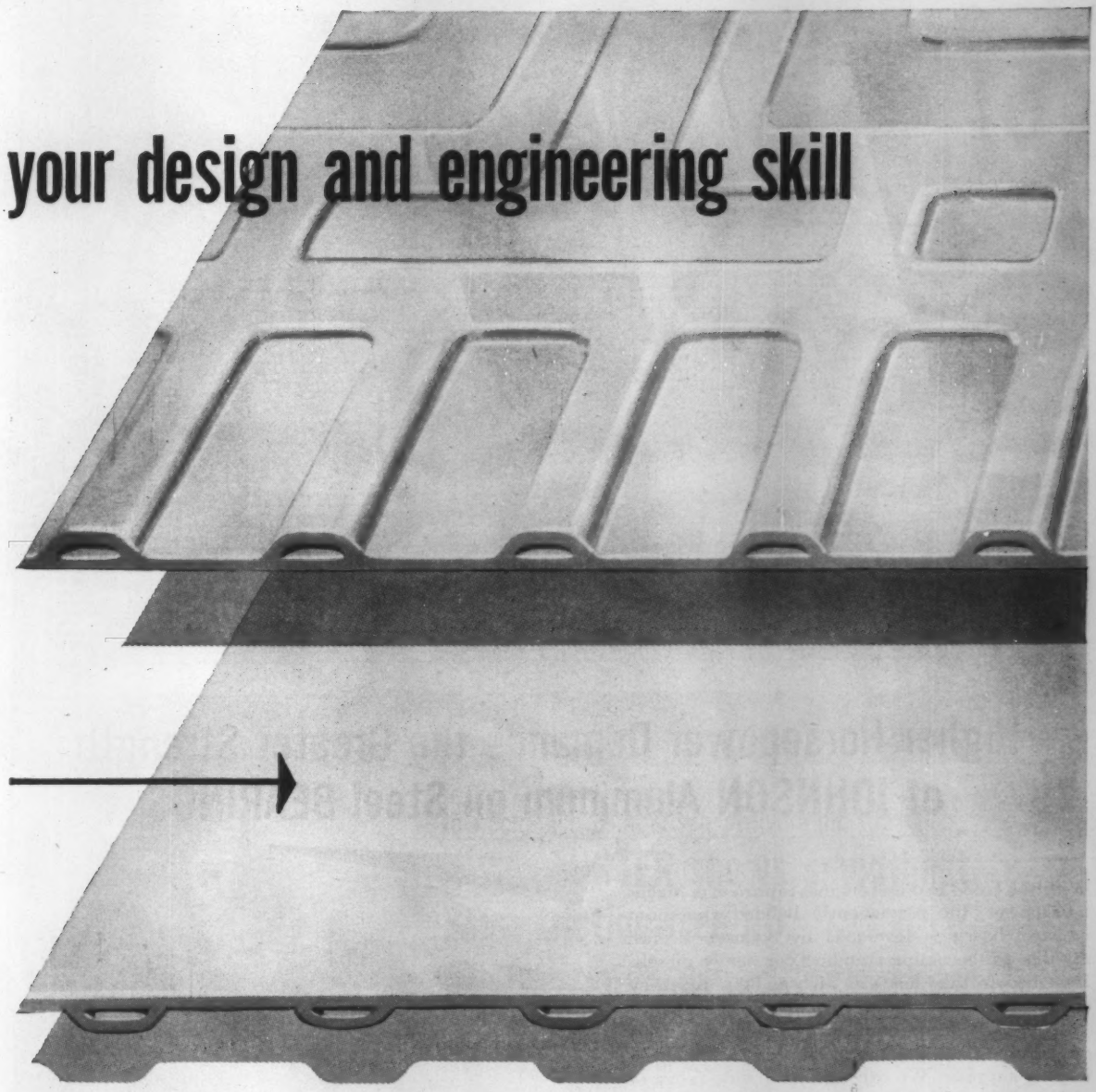
Why not investigate this intriguing new material for applications in your industry. Reynolds Aluminum Specialists will work with you on Tubed Sheet *One-Side-Flat* for heat transfer uses or for other uses your ingenuity may devise. For details, contact your nearest Reynolds office or write direct. *Reynolds Aluminum Fabricating Service, 2061 South Ninth Street, Louisville 1, Kentucky.*

Watch Reynolds All-Family Television Program "DISNEYLAND", ABC-TV.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

your design and engineering skill



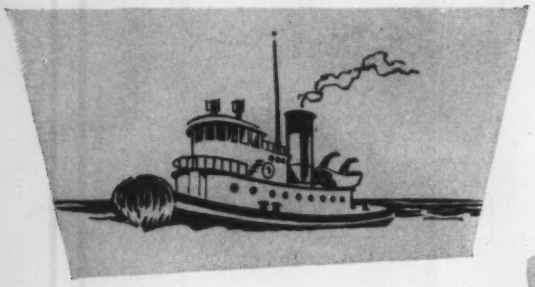
Tubed Sheet *One-Side-Flat* refrigerator freezing compartment. Note pattern on one side, other side smooth.

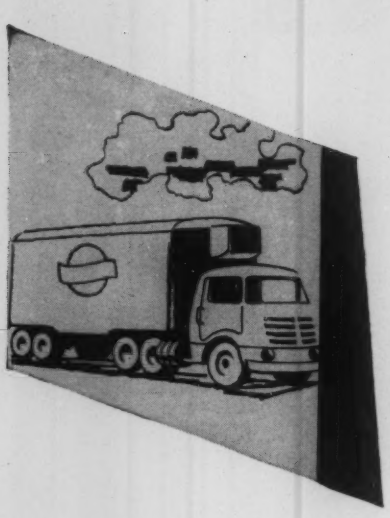
The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

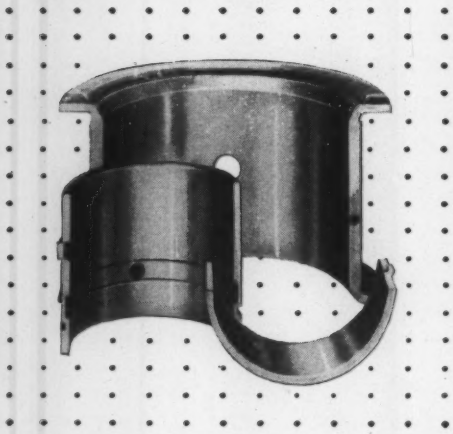
FABRICATING SERVICE

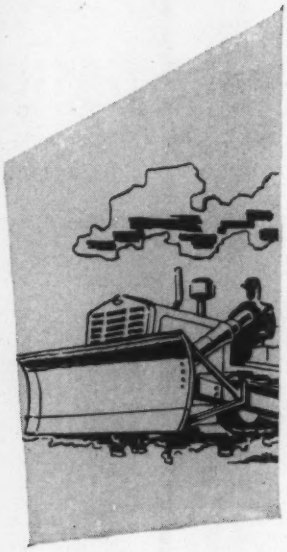
ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

Circle 462 on Page 19





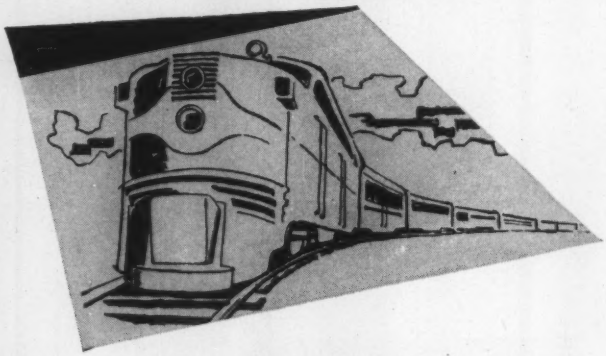




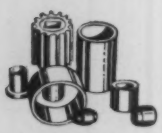
Higher Horsepower Demands the Greater Strength of JOHNSON Aluminum on Steel BEARINGS

With the trend in diesel engines toward ever higher horsepower, the permanently bonded aluminum on steel bearings developed by Johnson Bronze rapidly are becoming standard for heavy diesels. Designed to take loads as high as 5000 psi, they are ideal for heavy-duty, high-speed engines.

Johnson Bronze pioneered in the development of aluminum on steel bearings, and today is a leading supplier. We can furnish a wide range of plain or flanged, full or half bearings, with or without precision overlay. Take advantage of our years of experience and special production facilities—your Johnson Bronze representative will be glad to give you full details on how Johnson aluminum on steel bearings can improve your engine's performance. Johnson Bronze, 525 S. Mill Street, New Castle, Pa.



JOHNSON Bearings



POWDER METALLURGY—BRONZE OR IRON

ALUMINUM ON STEEL CAST ALUMINUM ALLOY

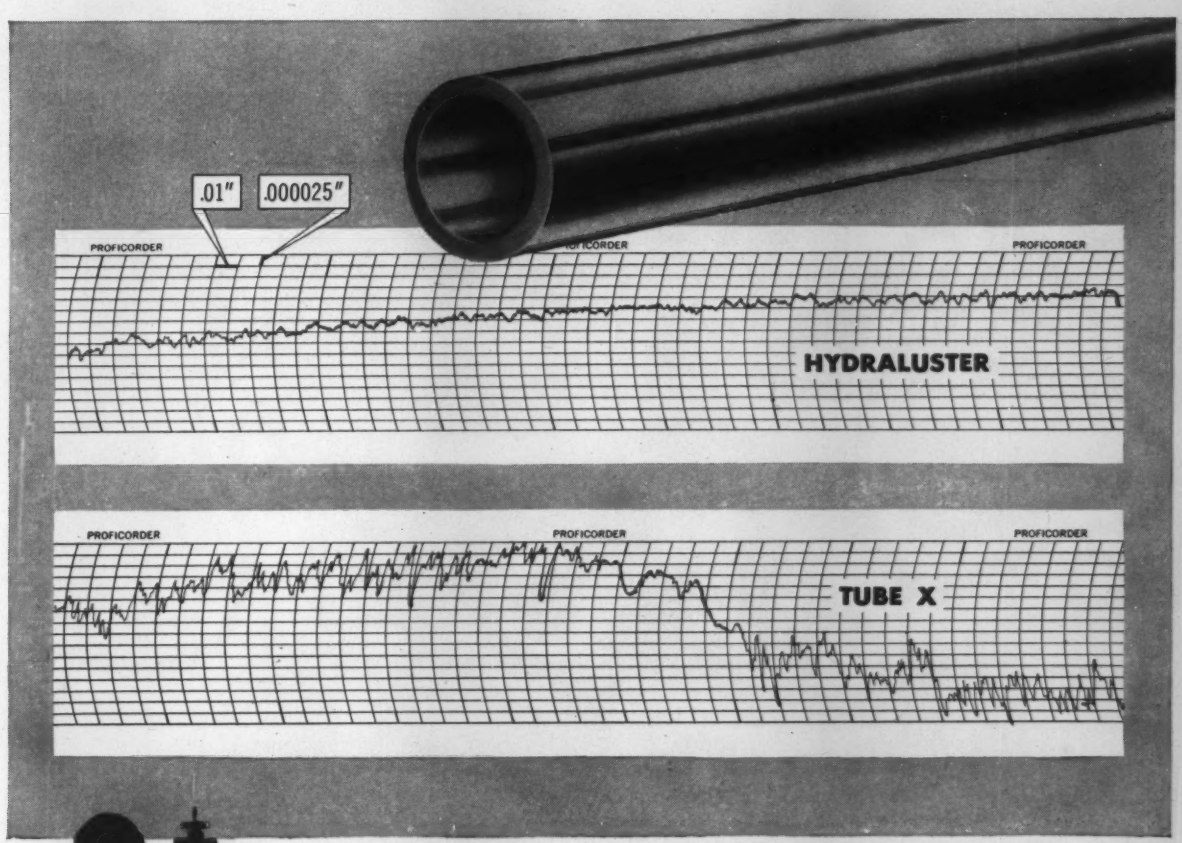
BRONZE ON STEEL

STEEL AND BABBITT

GRAPHITED BRONZE

BRONZE—CAST OR ROLLED

Circle 463 on Page 19



VERIFICATION: Measurements of Hydraluster and Tube X were made on The Proficorder—an instrument of our manufacture for accurately showing the true profile of practically any machined or finished surface. The tests were conducted in our laboratories under my personal supervision. And I verify that both tubes were measured under identical conditions. The resulting graphs show the exact differences in the samples furnished. **Douglas Palmer — Chief Inspector, Micrometrical Mfg. Co., Ann Arbor, Mich.**

In micro-inch comparison of hydraulic tubing . . .

HYDRALUSTER shows smoothest, most friction-free I.D.

These graphic red lines are recorded measurements showing a surface profile *inside* both HYDRALUSTER and a length of standard hydraulic tubing. *Both tubes were selected at random from warehouse stocks*, then accurately measured in microinches by the sensitive stylus of the famous PROFICORDER.

Hydraulic system efficiency and dependability, in a large degree, depend on factors illustrated by the red lines. Tube X is *not* a scrap piece of tubing. In fact, it represents a quality grade purchased and used every day. Which tube would you select to offer the least resistance to hydraulic flow . . . to transmit fluid with the least amount of pressure drop . . . and to create the least fluid turbulence?

Hydraluster is the answer, of course. And Hydraluster is the right tube to specify when you want to insure these same performance characteristics in your hydraulic systems.

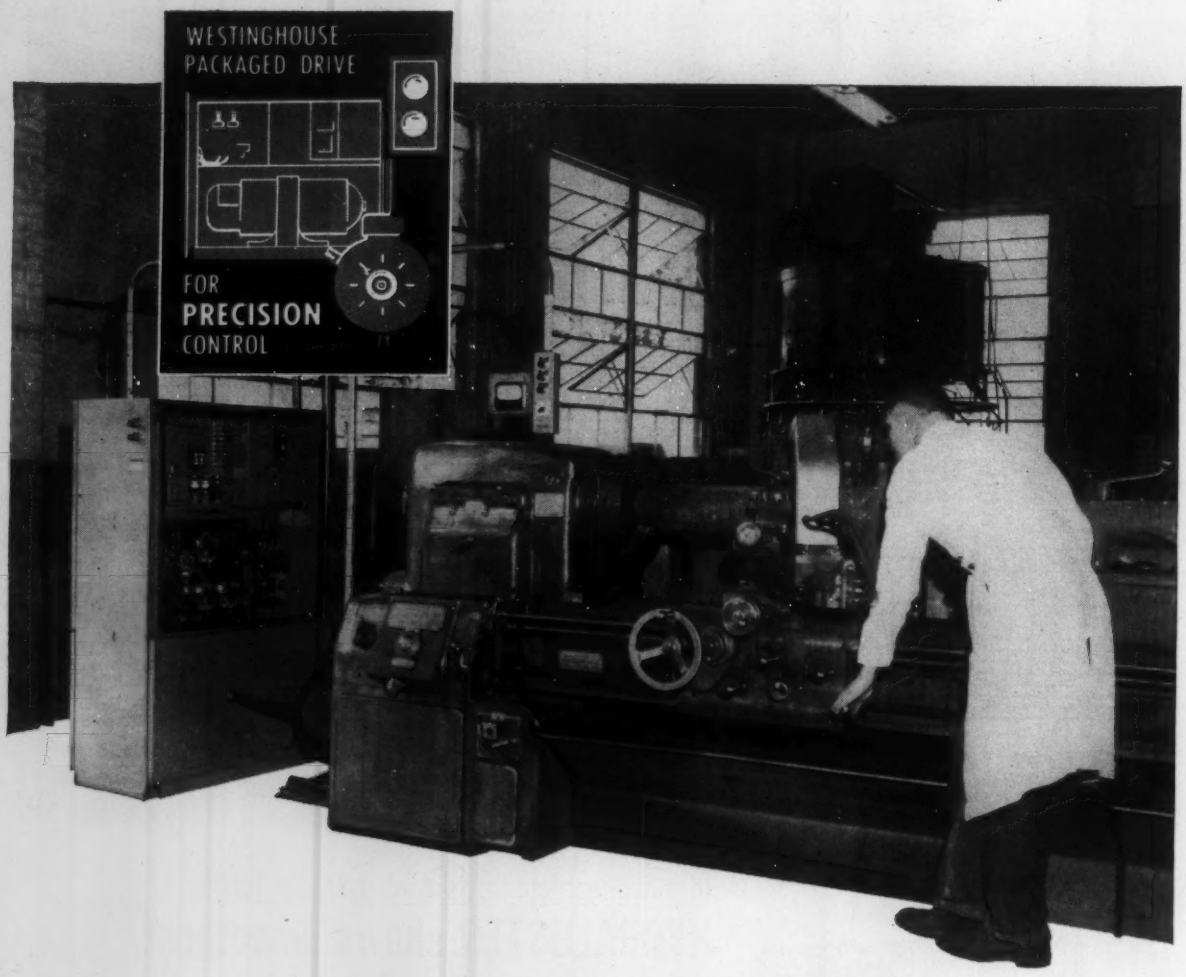
SAMPLES AND SPECIFICATIONS: Examine Hydraluster finish yourself. Your name on company letterhead will bring specifications and a sample by return mail. *Hydraluster is sold at standard carbon hydraulic tubing prices.*

Summerill

Tubing Company Division-Columbia Steel & Shafting Co.

PITTSBURGH 30, PA. DEPT. NO. 1-C

District Offices: Buffalo • Chattanooga • Cleveland • Dayton • Hartford • Philadelphia • Pittsburgh • Milwaukee • Chicago • Los Angeles • San Francisco



Westinghouse AV-DRIVE gives constant surface speed regardless of work diameter

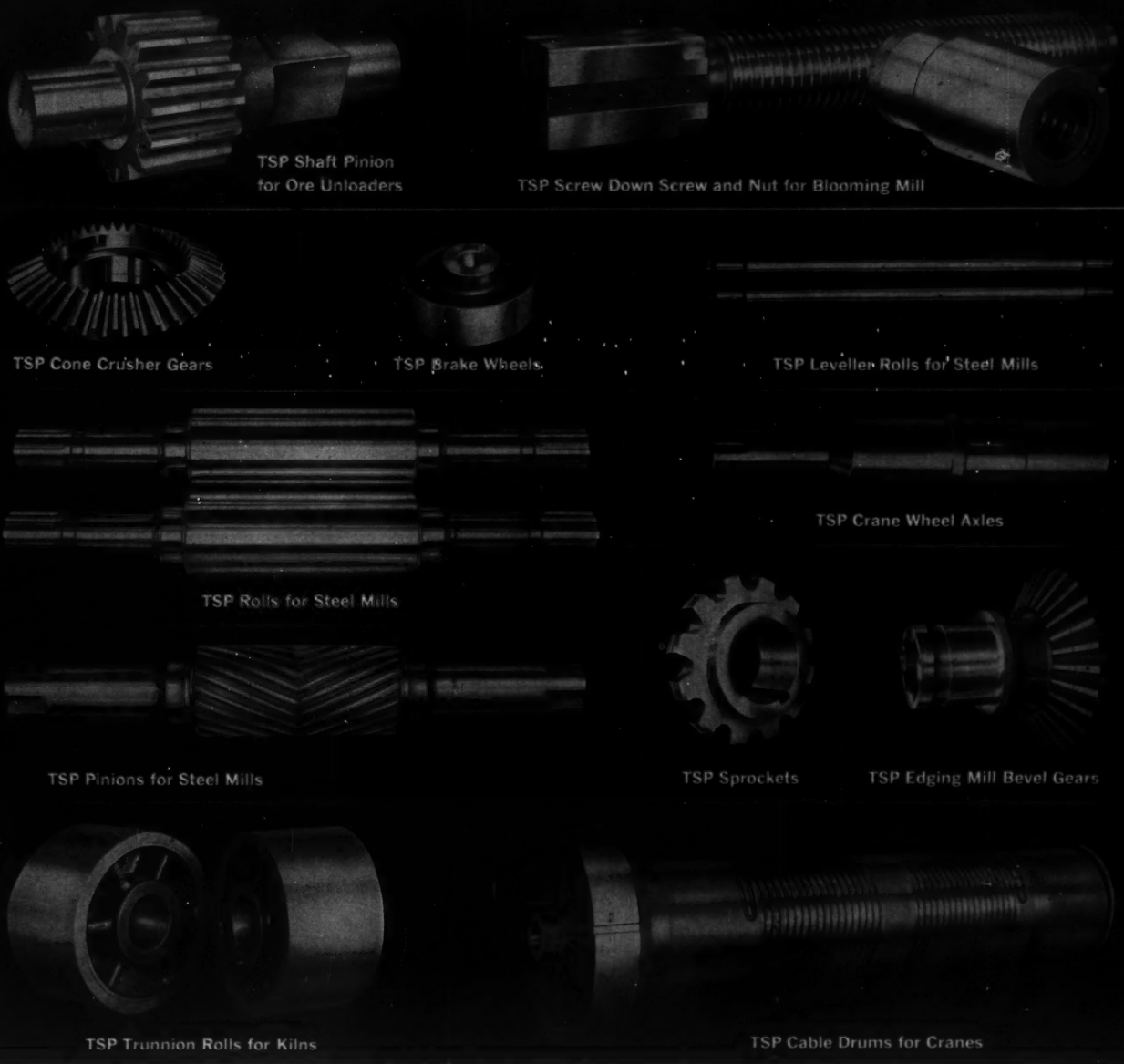
. . . at R. H. Bouligny, Inc., Charlotte, North Carolina

Eighteen hours a day, this tracer lathe is doing the work of an engine lathe . . . plus tracing at R. H. Bouligny, Inc., Charlotte, North Carolina. Constant surface speed, regardless of work diameter, is provided for precision template-guided cutting by a Westinghouse AV-Drive.

As the tracer mechanism traces over the template, the spindle speed is automatically controlled in accordance with tool position to maintain constant surface cutting speed. The template and work piece can be placed in the 20″ swing lathe and the machine takes over.

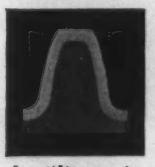
To learn how the versatile Westinghouse AV-Drive can make your production more profitable, call your local Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-22052

YOU CAN BE SURE...IF IT'S Westinghouse


TSP Shaft Pinion
for Ore Unloaders
TSP Screw Down Screw and Nut for Blooming Mill
TSP Cone Crusher Gears
TSP Brake Wheels
TSP Leveller Rolls for Steel Mills
TSP Crane Wheel Axles
TSP Rolls for Steel Mills
TSP Pinions for Steel Mills
TSP Sprockets
TSP Edging Mill Bevel Gears
TSP Trunnion Rolls for Kilns
TSP Cable Drums for Cranes

TSP parts give your product a big competitive advantage

Wherever you use a "Tool Steel Process" hardened part as a component, replacement problems are virtually eliminated. They are guaranteed in writing to outlast, out-perform any competitive part in the same service. TSP hardened parts increase the efficiency and quality of your product, resulting in greater customer acceptance. Their phenomenally long wearing qualities are a result of our special hardening process. The file hard surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. Note depth of hardness on gear tooth cross section.



TSP hardened parts, a few of which are illustrated, are made to order from your blueprints, or to fit existing equipment. Gears made in sizes to 90" diameter. Other products up to 20,000 lbs. weight. Write for Bulletin 352 "Why Are They Called TSP Products" and complete information about TSP applications for your product.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

AD 1028

The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

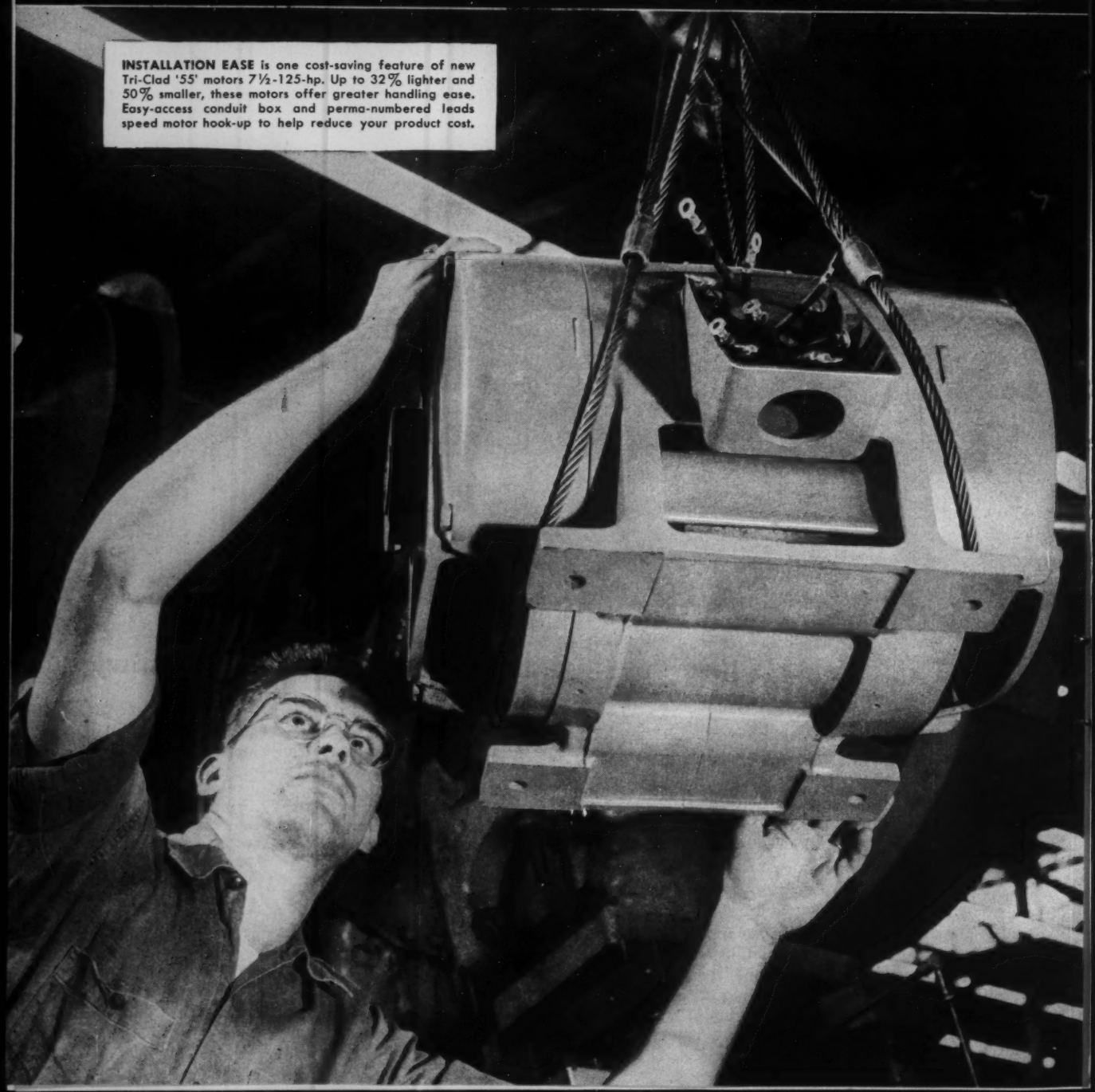
Circle 466 on Page 19

compact . . . power-packed

New General Electric

REDUCE YOUR

COMPLETE LINE AVAILABLE



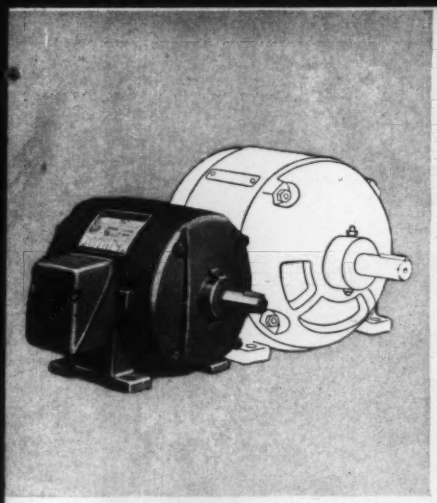
INSTALLATION EASE is one cost-saving feature of new Tri-Clad '55' motors 7½-125-hp. Up to 32% lighter and 50% smaller, these motors offer greater handling ease. Easy-access conduit box and perma-numbered leads speed motor hook-up to help reduce your product cost.

TRI 55 CLAD motors can...

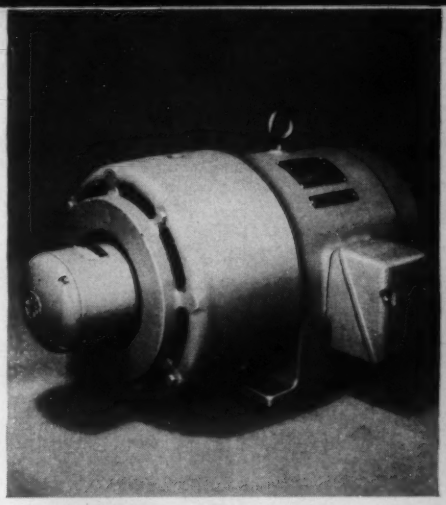
REG. U.S. PAT. OFF.

PRODUCT COST

THROUGH 125-HORSEPOWER



UP TO 32% LIGHTER and 50% smaller, new Tri-Clad '55' motors make it possible to reduce the size and weight of your products, or, with minor design modifications get greater capacity out of present machines.



"SPECIAL" MOTORS are built in G.E.'s new motor factory almost as fast as standards. Orders for "specials," such as this Tri-Clad '55' brake motor with plugging switch, are normally filled and shipped within a few days.

IMMEDIATE SHIPMENT of all popular Tri-Clad '55' motor ratings through 125-hp is provided by G.E.'s modern production facilities and a nation-wide network of warehouses. Fast shipment cuts your inventory costs.

immediate shipment . . . all ratings

Today's highly competitive market demands that equipment manufacturers take every possible step to reduce costs while maintaining or increasing product quality.

To help you accomplish this objective, General Electric has extended the proven Tri-Clad '55' motor line (formerly available only through 30-hp) up through 125-hp.

DESIGNED TO NEW NEMA RATINGS, the *complete* line of Tri-Clad '55' motors packs *more* power into *smaller* enclosures to improve your product design, reduce shipping costs and benefit your overall operation.

In addition, G.E.'s modern, automated manufacturing plant and nation-wide warehousing facilities make it possible to *reduce your motor inventories.* Now, *any* frame size of *any* popular Tri-Clad '55' motor rating through 125-hp is available for immediate shipment from nearby warehouse or factory stocks.

FOR COMPLETE DETAILS on the new, complete Tri-Clad '55' motor line contact your nearest G-E Apparatus Sales Office or Authorized Distributor.

Section D 891-8
General Electric Company
Schenectady 5, New York

Please send me the following publications:

☐ **FREE BULLETIN (GEA-6602) describes the many advanced features of new Tri-Clad '55' motors through 125-hp.**

☐ **FREE SLIDE RULE (GEN-148) to determine weight and space-saving benefits of new Tri-Clad '55' motors.**

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY & STATE _____

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 467 on Page 19

Vibration won't loosen FLEXLOC self-locking nuts

Where products must be reliable . . . must stand up under vibration, temperature extremes and hard use . . . designers specify rugged, reliable, precision-built FLEXLOC self-locking nuts.

HERE'S WHY:

FLEXLOC locknuts are strong: tensile strengths far exceed accepted standards. They are uniform: carefully manufactured to assure accurate, lasting locking action. And they are reusable: repeated removal and replacement, frequent adjustments, even rough screw threads will not affect their locking life.

Standard FLEXLOC self-locking locknuts are available in a wide range of standard sizes, types and materials to meet the most critical locknut requirements. Your local industrial distributor stocks them. Write us for complete catalog and technical data. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

We also manufacture precision titanium fasteners. Write for free booklet. **STANDARD PRESSED STEEL CO.**

FLEXLOC® LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

RX *MIXED-FLOW BLOWER UNIT: A TORRINGTON 1st*

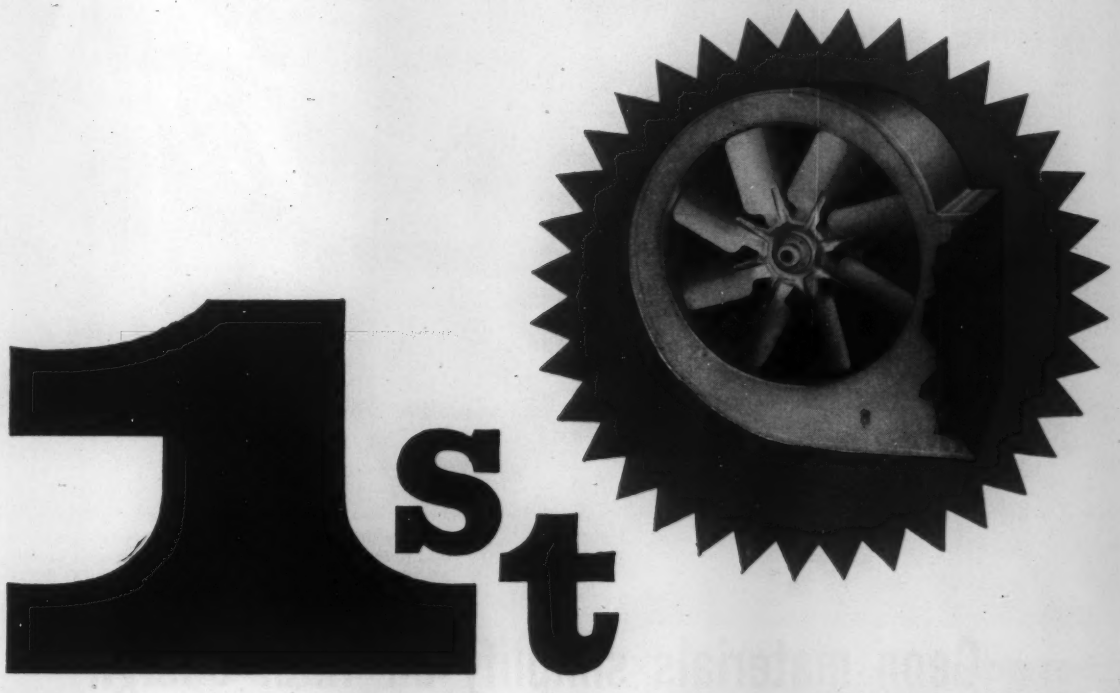
The Torrington RX Radiax blower introduces a new development in air impeller engineering.

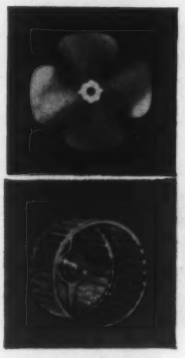
It is a direct drive mixed-flow unit employing an exclusive Torrington design concept which results in the conversion of axially-developed air pressure into a radial flow pattern.

The result of this design breakthrough is a versatile unit that can be tailored to an extended range of customer needs by modification of the axial fan configuration to exact performance specifications. This eliminates dependence upon a variety of different sized units for varying requirements.

The RX offers three important advantages:

PERFORMANCE—A flat power curve makes it a non-overloading unit, permitting the use of a single smaller-capacity motor for varying applications, and availability of the unit in sizes heretofore too large for direct drive applications.





CONSTRUCTION—A vertical center panel divides the unit longitudinally and supports the motor at its center of gravity. Resilient motor and fan mountings minimize noise and vibration. Result is quiet performance, and easy assembly and service.

ECONOMY—The basic design permits size reductions of as much as 36 per cent in the cubic dimensions of the unit, without sacrifice of performance. Thus, the RX is a thinner, more compact unit that can be fitted into tighter areas without choking of air intakes.

The design and performance of the RX give it a versatility that is of special importance to design engineers of air moving equipment. Full specifications are available.

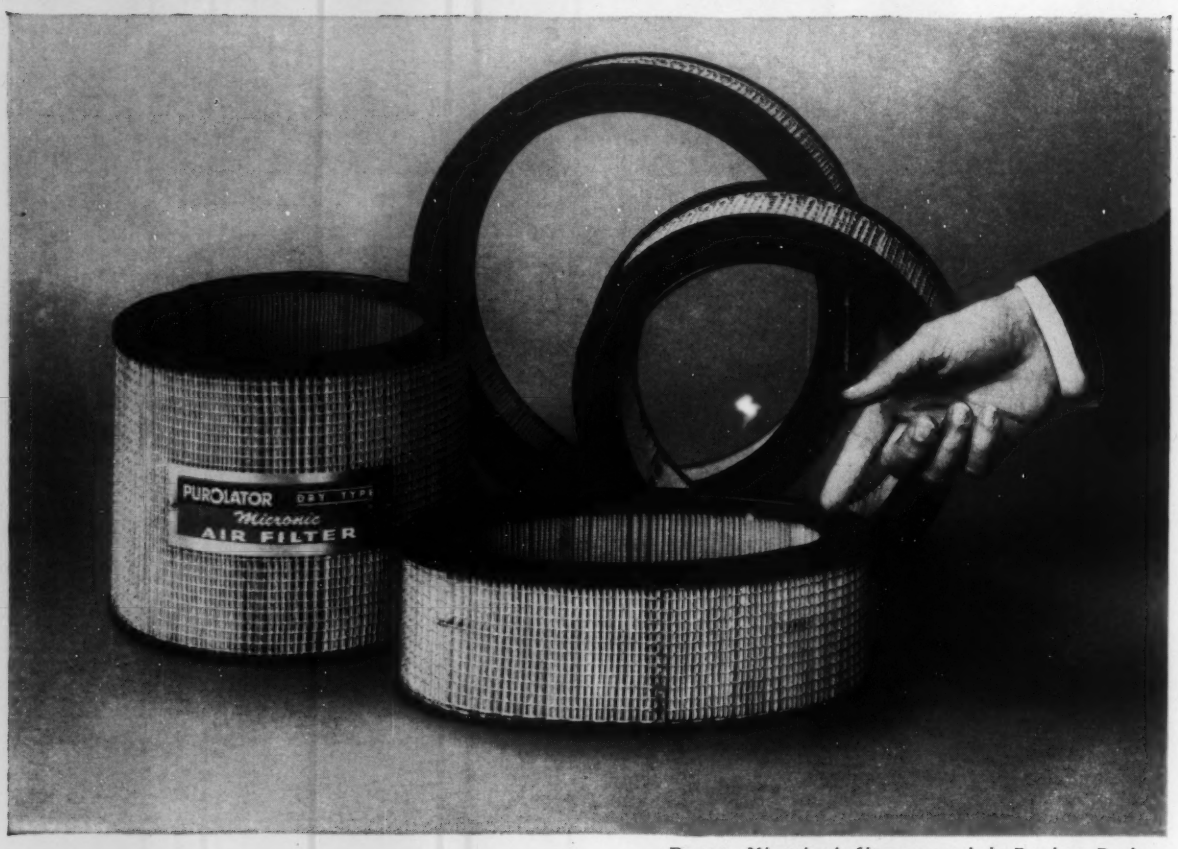
THE TORRINGTON MANUFACTURING COMPANY

TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

Circle 469 on Page 19

Another new development using

B.F.Goodrich Chemical *raw materials*



Dry type Micronic air filters are mady by Purolater Products, Inc., Rahway, N. J. in a variety of shapes to meet automotive requirements. End rings made from Geon supplied by B.F.Goodrich Chemical Company stay strong and flexible despite severe service.

Geon materials simplify air filter design

THESE dry-type Micronic automotive air filters were formerly made by assembling the filter element with metal end rings. This required a cementing operation, and a gasket was needed for sealing.

Now the end rings are formed by simply dipping the filter element into a mold containing a plastisol based on a Geon polyvinyl material. This eliminates the metal fastening operation, and since the plastic is moderately flexible, no gasket is required. In addition, with this design the manufacturer finds it more economical to tool up for the many sizes and shapes of filters needed in different cars.

Geon polyvinyl materials offer outstanding properties—resistance to water, oil, most chemicals, to wear and abrasion. And they are easily formed by molding, extrusion, calendering, casting, etc. For ideas on using Geon to advantage in your products, write Dept. GA-6. B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich **GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors**

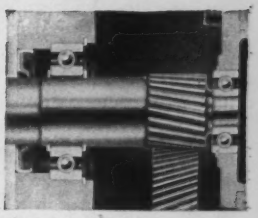
EFFICIENT NEW RUNNING MATE

for latest NEMA motor sizes . . .

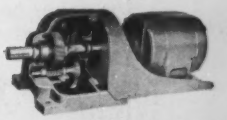
LINK-BELT Motogear designed for bracket-mounting foot-type motors of any manufacturer

EASY MOTOR REPLACEMENT—Remove four mounting bolts and separate coupling. Oil drainage is unnecessary. Sturdy bracket design aids motor re-alignment.

ABILITY TO ACCOMMODATE A WIDE RANGE OF MOTORS meets emergencies, minimizes downtime.



RIGIDITY of high-speed shaft and pinion is provided by straddle-mounting — extremely important in coping with shock, reversing or heavy loads.



ONE LOW-SPEED GEAR SET per drive size and maximum accessibility of all operating parts simplify inspection, maintenance and ratio changes.

Immediately available from stocks near you—new Link-Belt Motogears in sizes up to 60 hp, output speeds from 280 down to 6 rpm.

Wherever space is restricted . . . where downtime means a costly break in production continuity—Link-Belt Motogears soon pay their own way. In addition to easy motor replacement—simplified ratio changes and quick accessibility of parts for maintenance offer major service savings.

Contact your nearby Link-Belt office for facts. Ask, too, about the new flange-mounted Gearmotors stocked in sizes up to 30 hp. Or write for Book 2447, giving details of both.

LINK-BELT

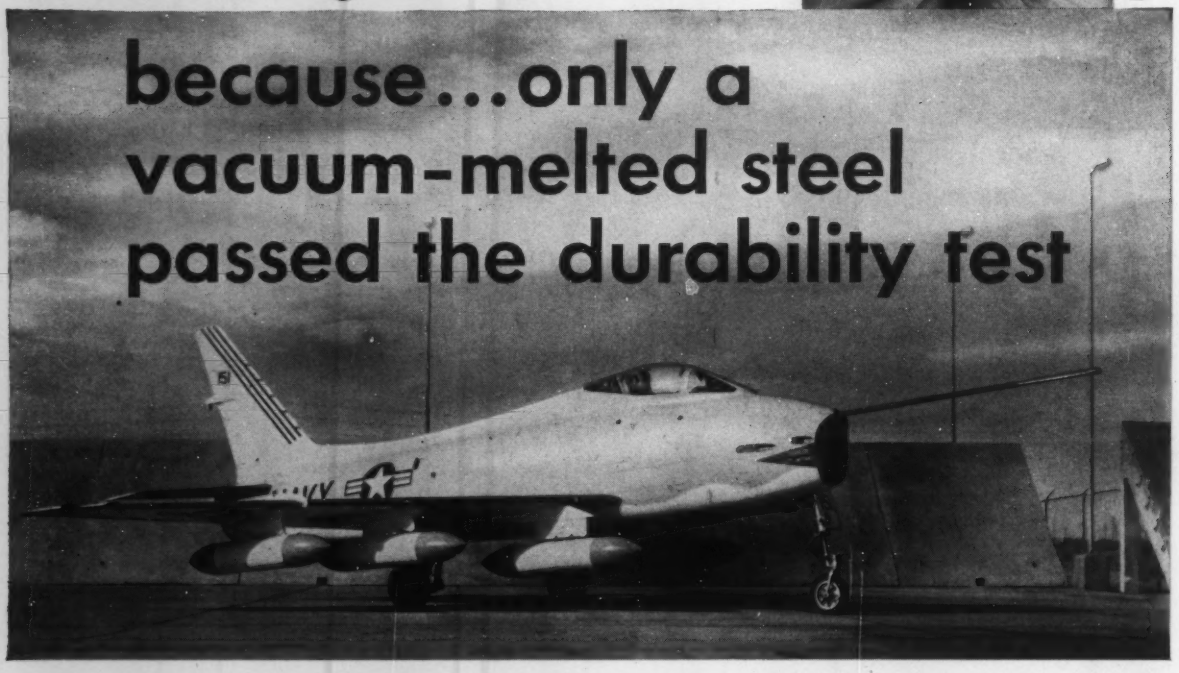
ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

14,318

The Ruffe, Inc. combination bomb rack and rocket launcher employs a hook pivot pin made from vacuum-melted steel

Why?



The hook pivot pin in the Aero 15B bomb rack and rocket launcher must be highly resistant to fatigue. To test this property, the pin must undergo 4½ hours of destructive vibration tests. It is subjected to vibration in each of three axes in turn with a frequency of 50 c.p.s. and a total excursion of 0.06 inches while loaded with a 500 pound store. This is no minor point, as the 500 pound store under these vibration conditions exerts a damaging and fatigue effect considerably more than a 500 pound load under any other test condition.

Air-melted steel did not stand up under this rigorous testing. But Ferrovac vacuum-melted 4340 steel emerged without apparent damage.

A vacuum-melted metal with such improved durability and strength may be just what you need when other types can't measure up to your rigid specifications. A VMC engineer will gladly help you explore this possibility. Thus the full technical resources of the first and largest producer of vacuum-induction melted metals will be placed willingly at your disposal. Write—describing your problem—in detail—to *Vacuum Metals Corporation, Division of Crucible Steel Company of America, P. O. Box 977, Syracuse 1, N. Y.*

Vacuum-melting is adding new performance to these metals. Do you have an application that may benefit from their use?

High temperature alloys	Bearing steels
High strength alloy steels	Tool steels
Low alloy steels for springs	Stainless steels
Nuclear reactor materials	Hard facing alloys
Special nonferrous alloys	Electronic alloys
Alloys for investment castings	Soft Magnetic alloys

VMC®

VACUUM METALS CORPORATION

Division of Crucible Steel Company of America

(Advertisement)

How to select gasket materials for low-cost flanges

Stamped, rough-finished cast, and other low-cost flanges require a gasket material that will seal irregular surfaces efficiently under the low bolting pressures usually available.

cork-and-rubber compositions

Such sealing jobs can usually be handled with truly compressible materials such as Armstrong cork-and-rubber compositions. These materials combine tiny cork particles in a continuous matrix of synthetic rubber. Varying the proportions of cork and rubber makes it possible to provide the right degree of compressibility for a wide variety of applications.

For extremely light assemblies, several Armstrong sponged cork-and-rubber materials with very high compressibility are available. When compressed to

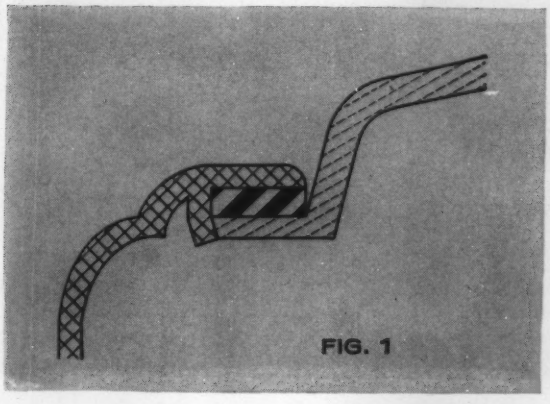


FIG. 1

the recommended deflection, these sponged materials are impervious.

solvent resistance

Cork-and-rubber materials generally have resistance to contained fluids comparable to that of straight synthetic rubbers of corresponding base polymers. Armstrong cork-and-rubber materials are available with nitrile-, styrene-, and chloroprene-type synthetic rubber binders. Two butyl compositions are also available. This group of synthetic binders makes it possible to seal a wide variety of fluids.

typical applications

A weathertight seal is provided by an Armstrong cork-and-sponged butyl gasket in an automotive taillight assembly, Figure 1. The material conforms to the normal irregularities in the plastic lens and die-cast rim and provides a tight seal in this pre-assembled unit. Excellent ozone-resistance imparted by the butyl binder assures long service life.

In Figure 2, another Armstrong cork-and-rubber compound provides an effective seal for the stamped hand-hole cover on a diesel engine. The softness of the gasket permits economical light-pressure assembly. Frequent opening and closing of the cover are facilitated, because the cork-and-rubber material resists fatigue and retains its sealing efficiency.

In the waterproof electric motor housing in Figure 3, an Armstrong cork-and-rubber composition accommodates surface irregularities in the stamped cover yet stands up under exposure to lubricating oils and sea water.

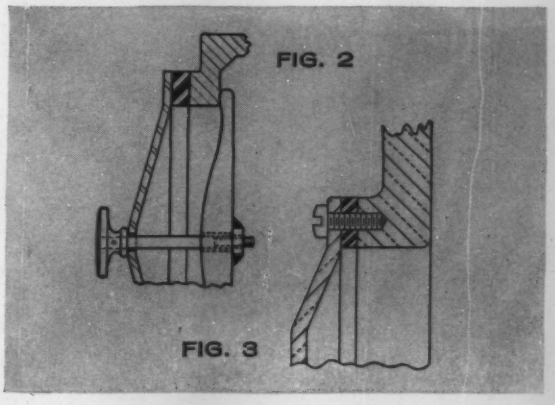


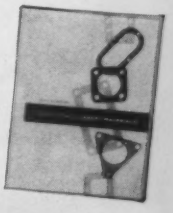
FIG. 2

FIG. 3

Sealing cost-cutting flanges is only one of many sealing jobs Armstrong cork-and-rubber materials can handle efficiently and economically. Your Armstrong representative will be glad to give you information as to how these materials might be used in your particular applications.

SEND FOR 1957 EDITION OF "ARMSTRONG GASKET MATERIALS"

This 16-page booklet discusses the choice of proper gasket materials and describes Armstrong cork, cork-and-rubber, synthetic rubber, and fiber sheet materials. Look for this booklet in Sweet's product design file. For a personal copy, write Armstrong Cork Company, Industrial Division, 7111 Dean Street, Lancaster, Penna.



Armstrong

GASKET MATERIALS

... used wherever performance counts

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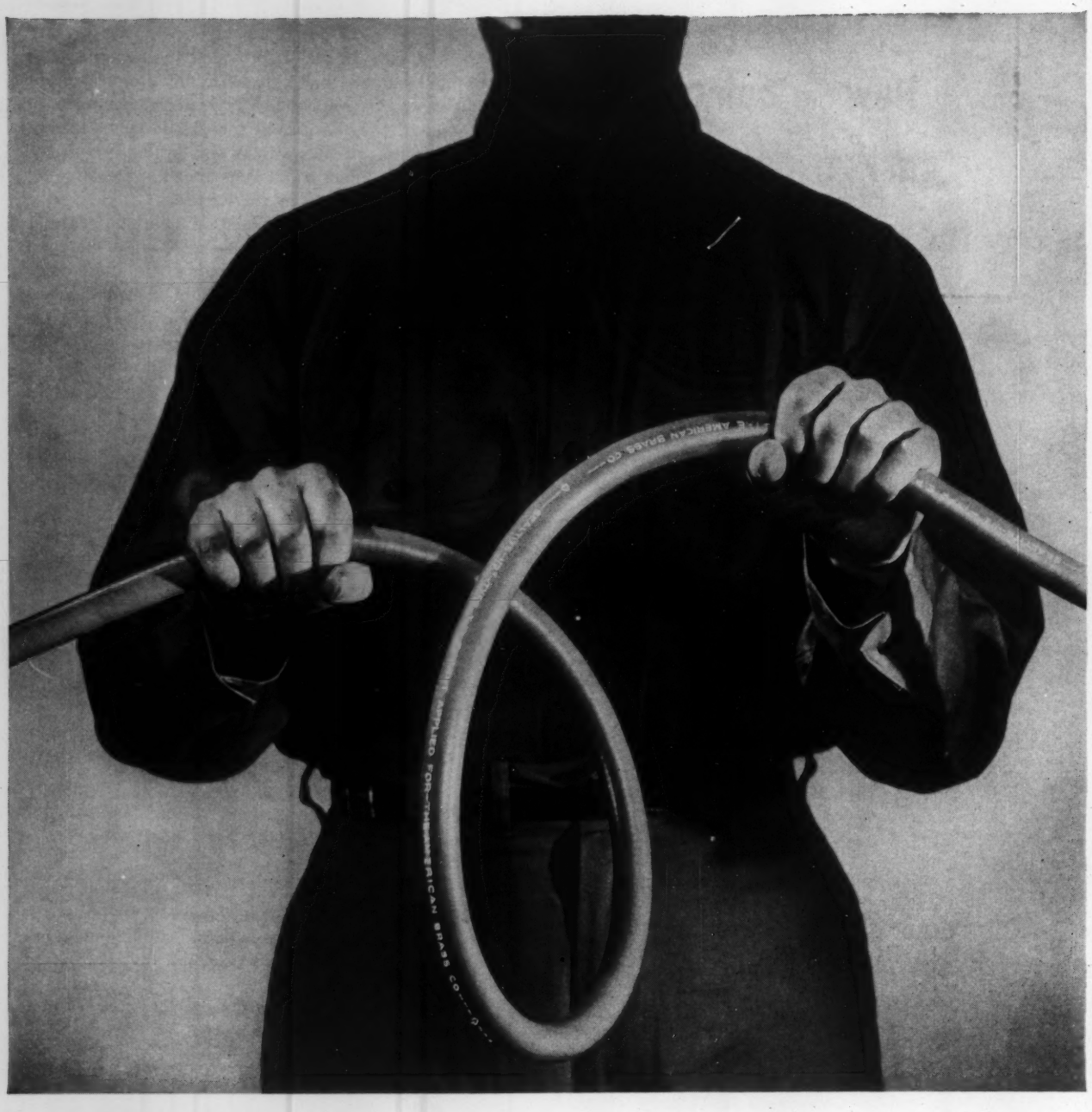


Announcing—the new, improved

New sturdier construction! New heavier jacket! Improved Sealtite* E.F. offers new superior performance in equipment . . . new installation ease. No extra cost!

Sealtite Type E.F.†—the original flexible, liquid-tight conduit, first to meet J. I. C. standards—is now better than ever. New design has made it stronger, tougher, more durable in service . . . easier to install.

Over-all construction is improved. Heavier extruded PVC jacket offers greater resistance to abrasion, cutting and tearing . . . greater oil resistance . . . greater holding power for fittings.

It is more flexible—permits smaller bending diameters. New convenient markings save time, prevent waste. Length is indicated by arrows at 1-foot intervals. Trade size in inches is also shown on cover.

Available in handy cartons, or nonreturnable reels,

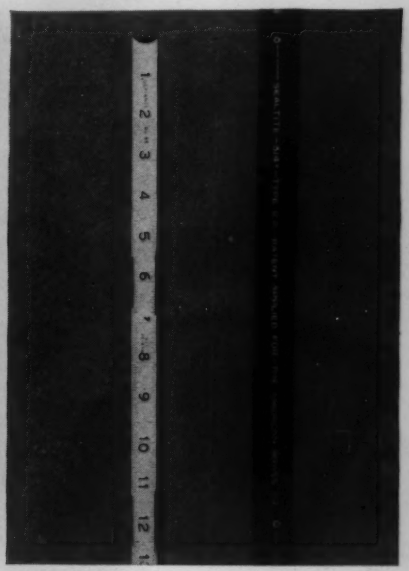
STRONGER. Over-all construction is stronger, more durable.

TOUGHER. Thicker PVC jacket resists abrasion, cutting, and tearing.

MORE OIL RESISTANCE. Liquid-tight jacket keeps out all foreign matter.

GREATER HOLDING POWER FOR FITTINGS — easier attachment.

GREATER FLEXIBILITY — smaller bending diameters — smoother cover even when flexed.



NEW MARKINGS — length and trade size are indicated at 1-foot intervals.

Sealtite E. F. flexible, liquid-tight conduit

at no extra cost. Reels simplify handling and cutting, reduce scrap, simplify storage, have handy charts for a running inventory.

Sealtite types E.F. and U.A. (U.A. is approved by Underwriters' Laboratories) in both black and machine tool light gray. For information, write: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn. *Trademark †Pat. Applied For 57199

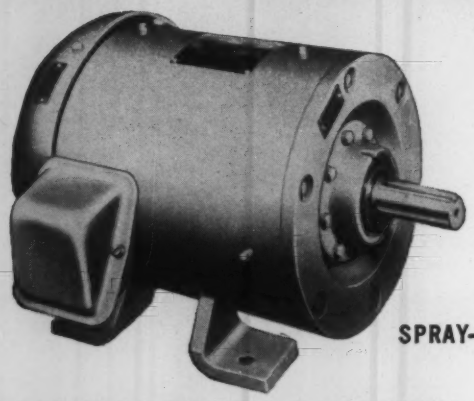
Insist on the conduit marked

SEALTITE

an ANACONDA® product

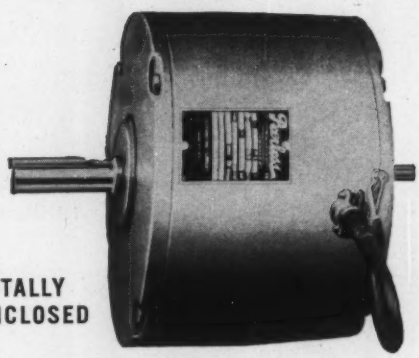
Circle 474 on Page 19

ONLY ONE MOTOR IS RIGHT FOR YOUR APPLICATION...



SPRAY-TIGHT

Fan cooled; 7½ HP; Navy; Hi-shock to Navy Spec. MIL-M-17060A.

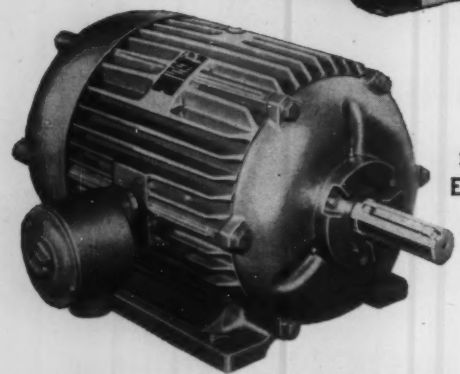


TOTALLY ENCLOSED

Blower and Drive Motor; 4 HP; air drawn over motor.

SPECIAL CONSTRUCTION

Motor to fit customer's application design.



STANDARD EXPLOSION-PROOF MOTOR

1 to 30 HP; also with NEMA C face and NEMA D flange.

● One thing's certain—just one motor is right for your application. Design engineers turn to Peerless more often than ever today because Peerless is equipped to produce the motors that power their machines best. There's no need to fit the machine to the motor. Peerless has hundreds of motor designs—many of them created specifically to meet OEM problems. Give your next motor problem to the Peerless Representative near you or write directly to the factory. We'll work with you to develop the one motor that meets your needs best.

ELECTRIC MOTOR DIVISION

THE *Peerless-Electric*® COMPANY

FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

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Circle 475 on Page 19

Ready, Set, GROW... with

The *economical* way to make your products strong, light and handsome is with Revere Aluminum Sheet. Economical because aluminum is so easy to handle and process, can so readily be given a surface finish of distinction.

Revere can serve you promptly now from plants in the East and Mid-West, and soon will be fully integrated as a primary aluminum producer. Revere Copper and Brass Incorporated. Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.

Revere Aluminum Mill Products include coiled and flat sheet, both plain and embossed; circles; blanks; Tube-In-Strip; extruded products; seamless drawn tube; welded tube; rolled shapes; electrical conductors; forgings; foil; frozen food containers. Write for new illustrated booklet on Revere Aluminum Sheet. Free!

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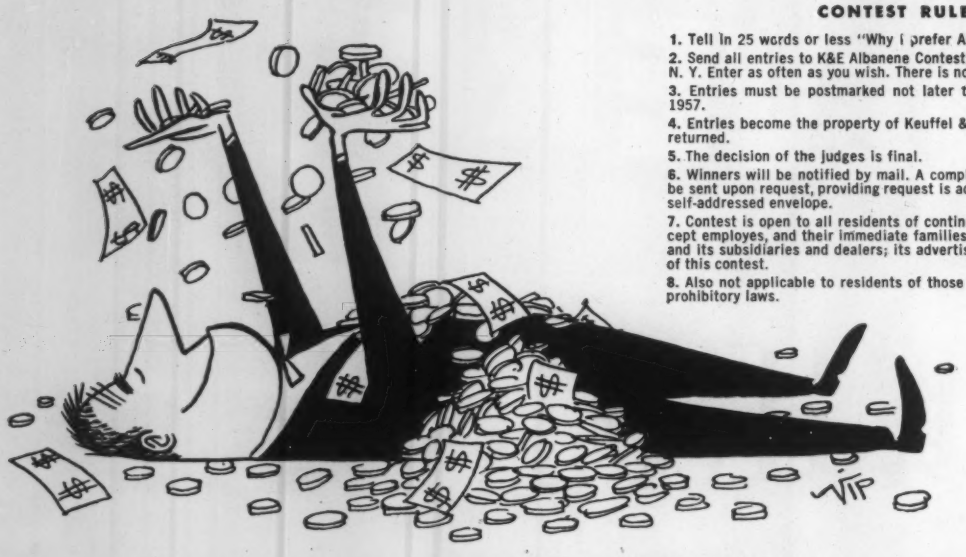
ENTER THIS CONTEST ...90 CASH PRIZES!



CONTEST RULES

1. Tell in 25 words or less "Why I prefer Albanene tracing paper."
2. Send all entries to K&E Albanene Contest, Box 160, New York 46, N. Y. Enter as often as you wish. There is nothing to buy.
3. Entries must be postmarked not later than midnight, Nov. 30, 1957.
4. Entries become the property of Keuffel & Esser Co. None can be returned.
5. The decision of the judges is final.
6. Winners will be notified by mail. A complete list of winners will be sent upon request, providing request is accompanied by stamped, self-addressed envelope.
7. Contest is open to all residents of continental United States, except employes, and their immediate families, of Keuffel & Esser Co. and its subsidiaries and dealers; its advertising agency; and judges of this contest.
8. Also not applicable to residents of those states where there are prohibitory laws.

Why I prefer ALBANENE® Tracing Paper...

First prize $1500
Second prize $1000
Third prize . . . . . $ 500

plus 87 prizes of $25 each!

In 25 words or less, tell us why you prefer K&E Albanene® tracing paper. Your reasons may win one of these 90 prizes (it's K&E's 90th anniversary).

Here's a hint: Albanene is made from 100% rag stock for superlative tear strength. It is permanently transparentized with an inert resin. Draftsmen like it because of its easy drawing qualities . . . reproduction men for its high transparency and permanence. Everybody likes it because "what you pay for stays in the paper." That's why Albanene is the best seller among *all* tracing papers.

Get contest aids from your K&E dealer: Information booklets, extra contest entry blanks, samples of Albanene, too, if you need them. You can enter as often as you please.

Or use a plain sheet of paper if someone's already snipped the blank below. Give your name, address, and firm name, twenty-five words or less telling why you prefer Albanene tracing paper, and mail to K&E Albanene Contest, Box 160, New York 46, N. Y. before midnight, November 30, 1957.

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New York, Hoboken, N. J., Detroit, Montreal, Chicago, St. Louis, Dallas, San Francisco, Los Angeles, Seattle.
Dealers in principal cities

K & E Albanene Contest, Box 160, New York 46, N. Y.

Here's why I prefer Albanene Tracing Papers_____

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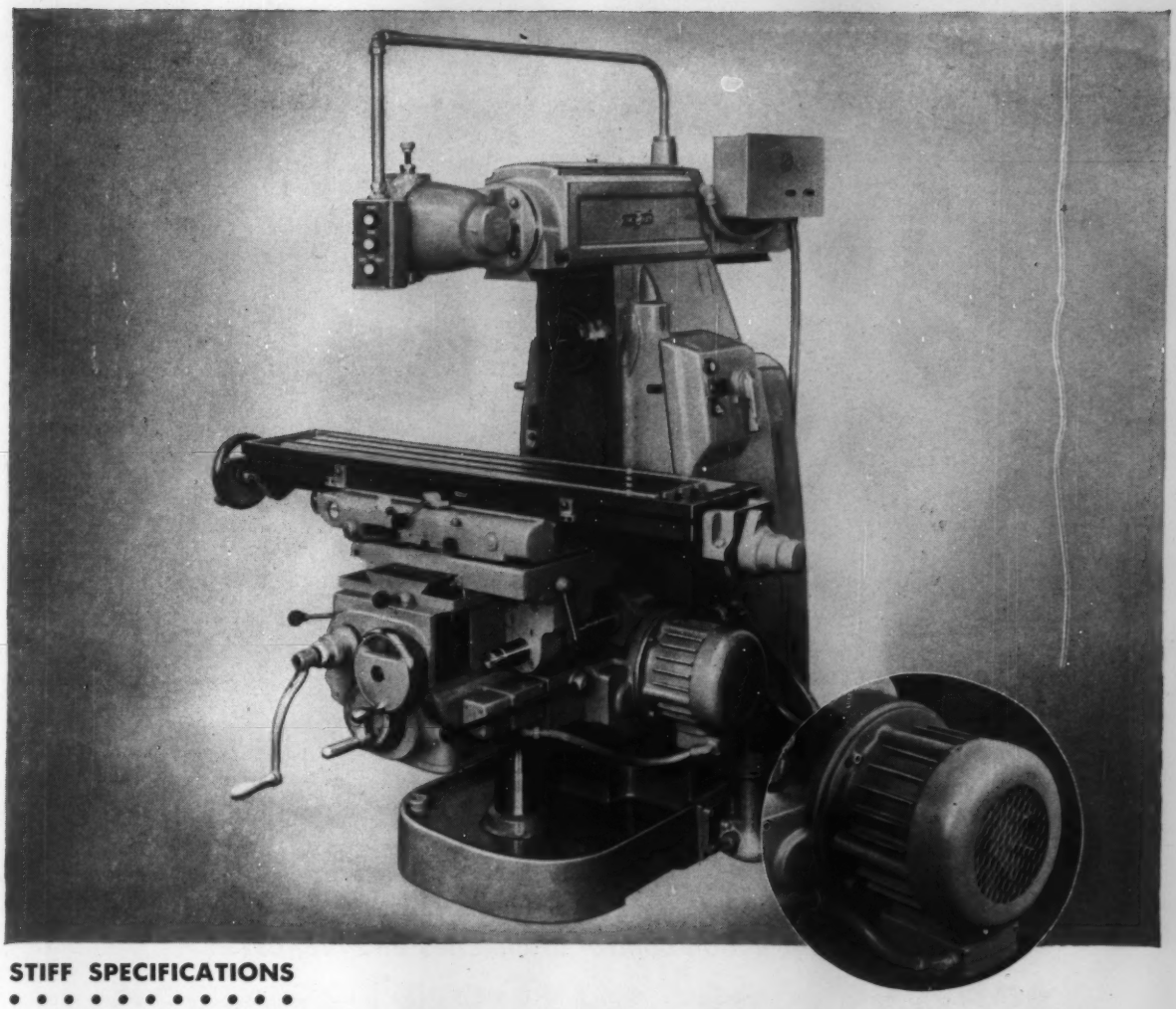
*Name*_____ *City*_____ *Zone*_____ *State*_____

*Street*_____ *Firm Name*_____



STIFF SPECIFICATIONS

Yet a DIEHL motor met all requirements

The requirements of one of the largest milling machine manufacturers called for a close-coupled, special duty motor to raise and lower the knee and develop sufficient torque for heavy table loads in rapid traverse without stalling. Cool operation was imperative to avoid distortion of the machine table due to heat transfer. The motor was to be mounted directly on the gear case, therefore complete protection against oil leakage into the motor was essential. Motor size, compactness and appearance were important factors. DIEHL developed the special totally enclosed motor illustrated, which met all desired requirements. Cool operation was assured by the fan-cooled design of the motor, effectively preventing heat transfer. The flat-type construction saved considerable space and overhang, conforming well with machine contours. Positive and dependable machine operation was the end result.

This is another example of DIEHL accomplishment based on almost three-quarters of a century of experience in the design and manufacture of motors for industry. Utilize this experience in the solution of your motor problems. We'll work closely with you to provide the right motor — at the right time — at the right price.

DIEHL MANUFACTURING COMPANY
Electrical Division of
THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Diehl

☐ Please send me Consolidated Motor Catalog and Price List No. MD-11—3540

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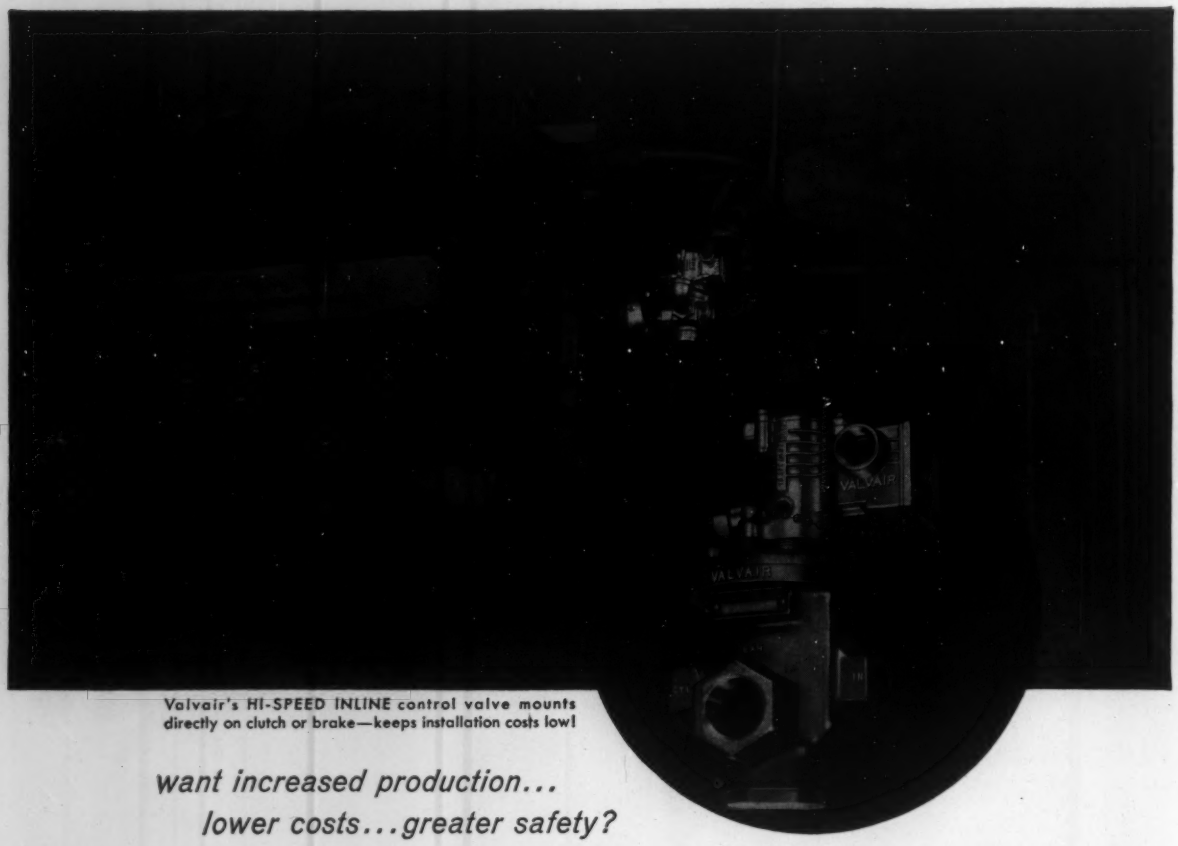


Valvair's HI-SPEED INLINE control valve mounts directly on clutch or brake—keeps installation costs low!

want increased production...
lower costs...greater safety?

use VALVAIR'S HI-SPEED INLINE VALVES

for instant-action control of clutches and brakes!

The split-second response of Valvair's pilot-operated HI-SPEED INLINE valves means shorter machine cycle time . . . more work per hour . . . more accurate cuts for high speed cut-offs . . . less clutch and brake slip . . . lower maintenance costs! And, precise control cuts machine set-up time . . . assures safer operation by minimizing drift.

Short travel, air cushioned poppet action is the HI-SPEED INLINE'S speed secret. Simple design assures multi-million cycle dependability . . . the valve has only 3 moving parts!

Built to Valvair's high standards, the HI-SPEED INLINE features cast Navy M bronze bodies, pilots built to JIC standards and fully interchangeable with your Speed Kings, solenoid coils guaranteed against burn-out for the life of the valve, plus molded Hycar poppet seals. Manual over-ride and integral junction boxes optional.

Valvair HI-SPEED INLINES *are available for immediate delivery from stock*, in sizes and types for every need. Specify them on new equipment . . . use them to replace obsolete valves now in service . . . one installation will convince you! Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.

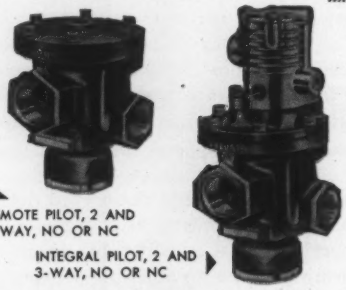
AA-5250

Find your nearest representative in the 'Yellow Pages'

Compare . . . and you'll buy

Valvair

Sizes range from ¼ to 1½ in. NPT. Solenoid pilot coils for ac or dc, any voltage. Working pressure, 10 to 200 psi.



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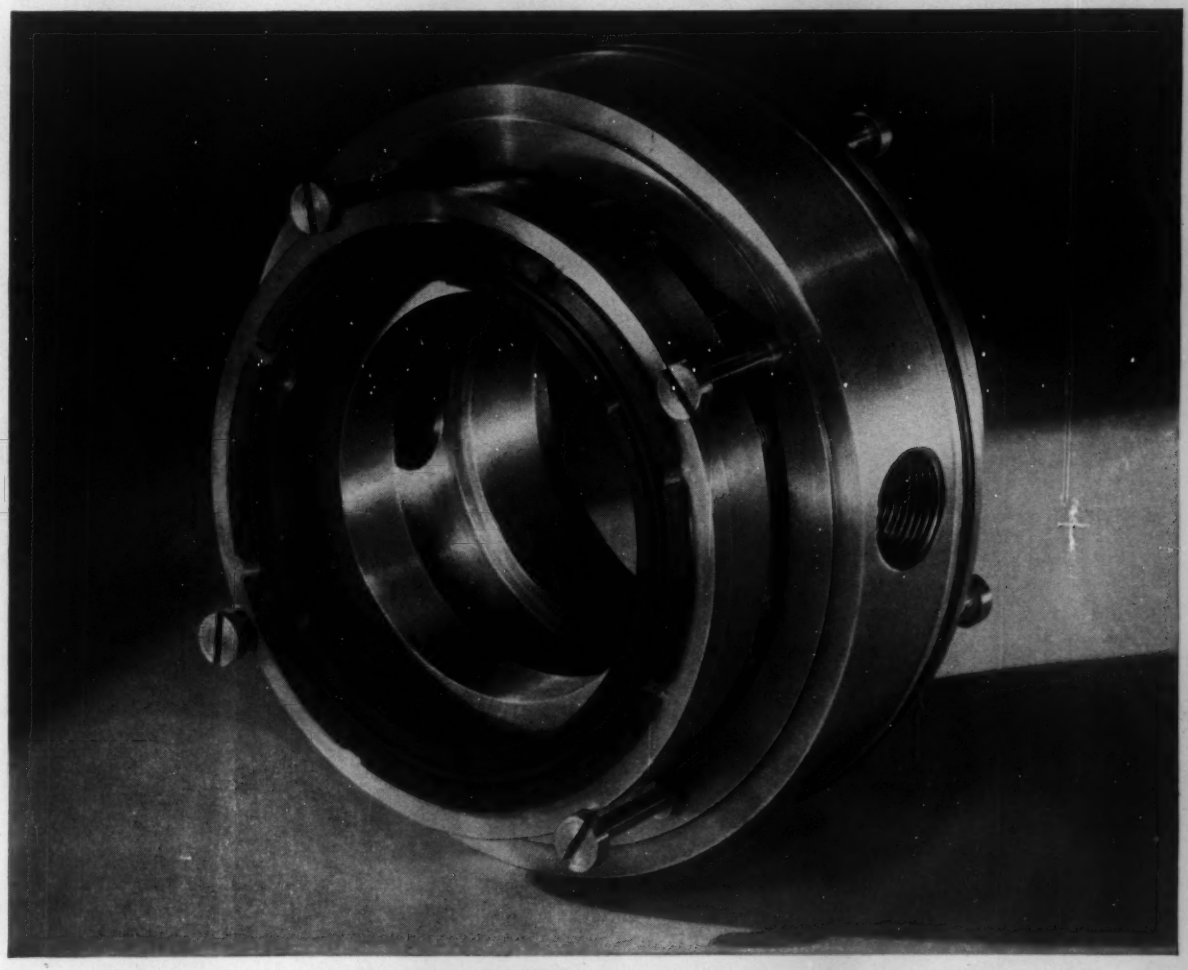

Koppers Face Type Seal Provides Up to 20,000 Hours of Service!

Up to 30,000 Hours in Laboratory Tests Using Clean Gas!

Koppers engineering has created an unmatched sealing surface that gives Koppers Face Type Seals a much longer-than-ordinary service life.

The exclusive design of the sealing surface keeps pressure distribution and hydraulic balance unchanged during operation . . . permits a light face loading which lowers interface temperatures. Hydraulic balance allows sealing of gases and liquids through a wide range of rubbing speeds. Rugged construction adds to Koppers long service life. Rotating collars can be of hardenable stainless steels, cutlery and die steels, Stellites, or of a hard chromium or carbide face. Ring is of carefully selected grades of carbon.

If you have a sealing or piston ring problem, Koppers entire research, production and engineering facilities are at your disposal. For more details, write to the KOPPERS COMPANY, INC., 2311 Hamburg St., Baltimore 3, Maryland.

Koppers Company, Inc.
Metal Products Division
Piston Ring and Seal Dept.

***Engineered* Products**
Sold with *Service*

KOPPERS®

MECHANICAL SHAFT SEALS

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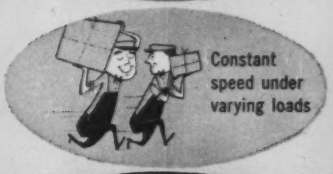
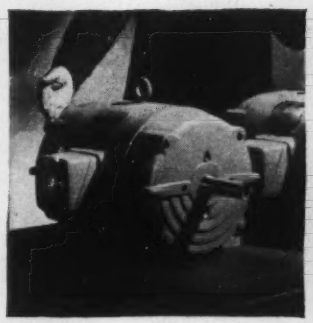




They look like twins — but one is synchronous

Louis Allis "Syncro-Spede"* offers—for the first time—a synchronous motor in the same frame sizes as a standard induction motor

New from Louis Allis — *the most compact and efficient synchronous induction motor on the market* . . . the revolutionary "Syncro-Spede." It's the *only* synchronous motor built in standard NEMA frames for comparable ratings in any enclosure.

The space-saving "Syncro-Spede" has no external excitation, wound rotating fields, collector rings or brushes—offers simplified control and low-cost operation, virtually maintenance-free.

In performance, "Syncro-Spede" delivers and maintains exact synchronous speed within its rated capacity, regardless of load variations or voltage dips. When powered by a single adjustable frequency source acceleration, running speed, and deceleration of several different ratings of "Syncro-Spede" motors can be synchronized.

"Syncro-Spede" is the low-cost answer to such demanding synchronous applications as *precise adjustable-frequency multi-motor systems*... high-frequency generator drives and constant-speed conveyor drives . . . precision timing and metering devices . . . recording instrument drives . . . any system requiring constant speeds from no-load to full-load.

"Syncro-Spede" sizes range up to 100 hp. For information and expert application engineering assistance, contact your nearby Louis Allis District Office or write directly to The Louis Allis Company, 459 East Stewart Street, Milwaukee 1, Wisconsin.

*"Syncro-Spede" is a trademark of the Louis Allis Co.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 481 on Page 19

Titanium Tubing

For processing lines carrying fluids of an extremely corrosive nature — look to *Contour Trentweld* titanium tubing for reliable service.

This titanium tubing is completely uniform throughout any cross-section. The weld zone is free from bulging weld bead because Trent's exclusive process — performed with the weld area at the bottom — forms the molten weld metal into the shape of the tubing.

And, with titanium, you get the unique advantages of a tubing that's strong as steel but 44% lighter . . . virtually immune to a broad spectrum of corrosive materials . . . entirely free from stress-corrosion cracking.

So, next time you need a strong, light, extremely corrosion-resisting tubing — try *Contour Trentweld* titanium tubing. And remember, it's made by Trent — tube mill specialists.

CONTOUR TRENTWELD

Stainless and High Alloy Welded Tubing

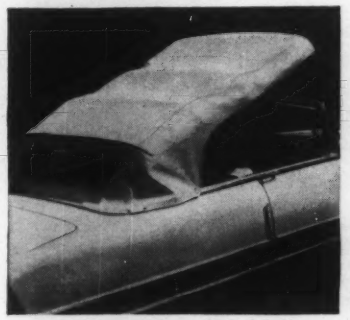
TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of Crucible Steel Company of America)

Circle 482 on Page 19

News about HYPALON®

Convertible top coated with HYPALON resists sunlight, weathering, discoloration, cracking

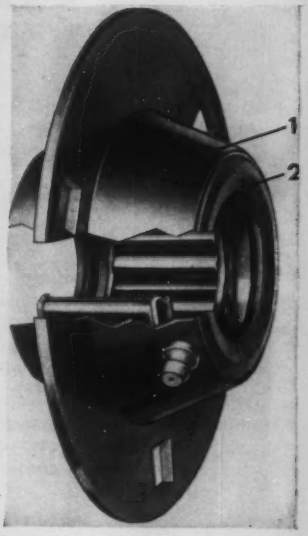
When one large automotive manufacturer wanted a convertible top for new models that would give longer wear, HYPALON was specified as the coating over the canvas body. This newest Du Pont synthetic rubber was chosen because it will not crack or harden under prolonged exposure to weather, and is exceptionally resistant to the effects of sunlight. HYPALON can also be compounded in a wide range of stable colors . . . important as a styling consideration in the competitive automotive industry.



HYPALON offers almost unlimited industrial design possibilities. It is particularly adapted to applications where exceptional ozone resistance and resistance to oxidizing chemicals are important. HYPALON also shows unusual resistance to hardening at elevated temperatures (250°-350° F.). For full information on the useful properties of HYPALON for design, just mail coupon below.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

Bearing gives smoother performance, longer life because of neoprene housing and shaft seal



1. Neoprene housing permits shaft alignment changes.

2. Neoprene seal retains lubricant, seals out dirt.

Flexible neoprene housing on roller bearing adapts to instant changes in shaft alignment

This new cartridge type roller bearing, introduced by the Rollway Bearing Company of Syracuse, N.Y., is designed for farm and industrial materials handling equipment. It is made in shaft sizes from 1/2 to 1 7/16 inches. The bearing's flexible neoprene housing adjusts to shaft alignment changes caused by vehicle movement, or shifts in load distribution on pulleys attached to the shaft. It permits misalignment between shaft and bolting flange of at least one degree. This adds considerably to bearing life and cuts fatigue on walls or panels to which the flange is mounted.

Rollway specified neoprene for the housing and shaft seal because it *keeps* its flexibility despite hard wear and extremes of temperature and humidity. Neoprene was also chosen for its outstanding resistance to oil and grease and the abrasion of dirt and grit. Regular bearing lubrication has no effect on the neoprene seal.

It's this *balanced combination* of properties that makes neoprene so useful for applications where severe service conditions would ruin ordinary rubber or less resilient materials. Neoprene resists acids, oil and grease, abrasion, sunlight and weathering. Mail coupon below for details on how neoprene's many useful properties have been designed into many industrial products, and how they can work for you.

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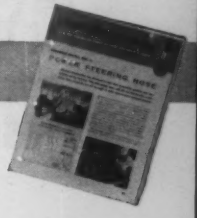

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1. Rotor spins between inner and outer field poles.
2. Both field poles are shaded properly with heavy, continuous copper rings.
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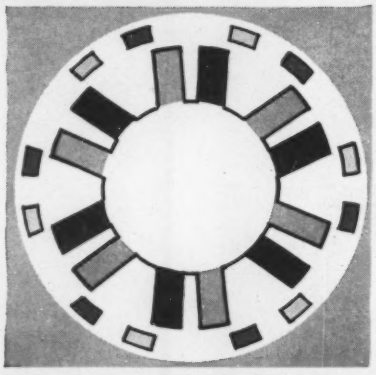

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DEPEND ON SYNCHRON — 5 Quality Motors . . . by HANSEN

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Compactly built to space saving dimensions, with rotor and coil packed in a sturdy [illegible] case. Used in [illegible] devices and controls of all types. Guaranteed torque 8 in. oz. at 1 r.p.m.

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A new timing motor developed especially for slow motion [illegible]. Guaranteed [illegible] 20 in. oz. at 1 r.p.h. [illegible])

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HANSEN MAGNA-TORC DC MOTOR

Designed for aircraft instruments and radio controls. [illegible] applications. [illegible] its top [illegible] world-wide under [illegible] rating conditions. Easily adapted to commercial uses.

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ATTENTION DESIGNERS:

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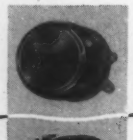

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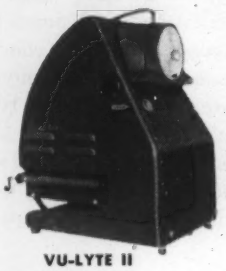
Circle 484 on Page 19

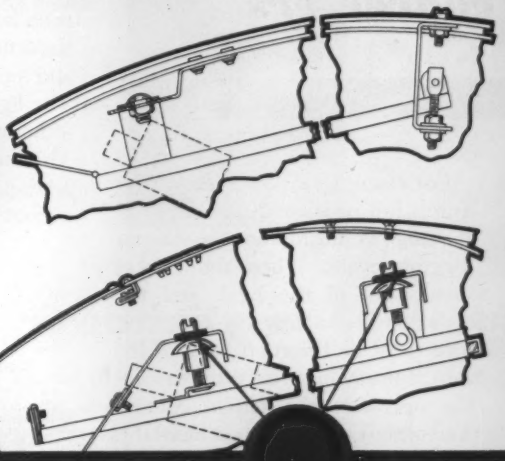
Waldes Truarc Rings cut assembly costs, improve performance of precision photo-optics equipment

Charles Beseler Co., E. Orange, N. J. uses Waldes Truarc Retaining Rings in 3 applications shown.

REFLECTING MIRROR ASSEMBLY IN OPAQUE PROJECTOR



VU-LYTE II PROJECTOR



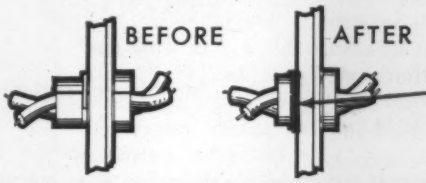
BEFORE

"The front surface mirror is the most precise optical element in a properly-functioning opaque projector," Beseler writes. "Previously we used this extremely cumbersome means of holding the mirror in position. As mirror adjustments are always required and the mirror is extremely delicate, our spoilage was terrific."

AFTER

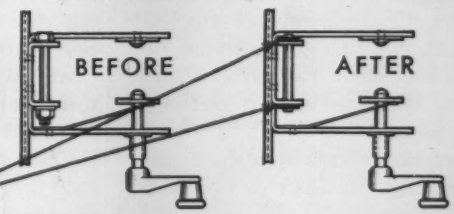
"Two Truarc Series 5100 Rings made possible complete redesign of the mirror assembly. Now mirrors can be adjusted from *outside* the projector. Rejects now are practically nil. More precise adjustment of the mirror is possible. And because of the greater ease in adjustment, we have cut labor costs $2.00 per unit."

HEAT ASSEMBLY IN PRINT DRIER



Here a Waldes Truarc crescent ring, Series 5103, replaced a split collar and clamping ring. Results: labor costs cut 50¢ per unit because of greater ease of assembly. Drier provides more uniform heating.

35 MM MICRO-FILM NEGATIVE CARRIER IN ENLARGER



2 Waldes Truarc Series 5133 E-Rings replaced 2 cap nuts—at a saving of 20¢ per unit in labor costs.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

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Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U.S. and Canada.

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(Advertisement)

The "how and when" of output shaft governors on torque converters

In 1940, Twin Disc Clutch Company began experimenting with governors as applied to output shafts of torque converters. Since then, output shaft governors have been used with torque converters on many applications such as power shovels, road rollers, motor graders and similar machines.

While Twin Disc does not manufacture nor normally supply output shaft governors with torque converters, the company nevertheless realizes that such governors can do much beneficially to control or alter torque converter output performance curves.

Technically an output shaft governor system consists of two governor devices: one driven by the converter output shaft, the other by the engine. Either governor can control the engine speed depending on its load and rpm setting. At output speeds below the output shaft governor's maximum setting, the engine governor controls engine speed and power between idle and full load. As the load drops off and output shaft speed reaches maximum setting, the output shaft governor takes over by throttling back the engine either through the engine governor or by working directly on the fuel control to maintain constant torque converter output shaft speed.

Output shaft governors are used for two primary reasons:

A. To prevent, under light or no load conditions, the converter output shaft from exceeding a predetermined maximum operating speed.

B. To provide a constant output shaft speed under normal working load conditions.

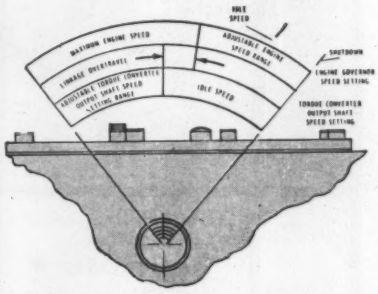
For example, a power shovel requires full power only a portion of the time, as during the crowding or digging cycle. When the bucket breaks out of the bank and the operator begins his swing, the engine must be throttled back or the rate of the swing will be too fast for the operator to maintain control. The output shaft governor does this automatically since as soon as the output shaft tends to overspeed its maximum permissible rpm, the output shaft governor takes control over the engine governor and throttles back the engine.

A road roller or grader illustrates the second point since for uniform road finish a constant vehicle speed is desired regardless of the contour or character of the terrain.

Output shaft governors can be installed in several ways. A single lever can be installed to control both governors or, of course, a separate control may be used for each. In some applications the output shaft governor setting can be fixed and only the engine governor varied.

Choice of control arrangement, of course, depends on the application. A convenient arrangement, say for a mobile crane, is the single lever control. The first part of the lever's travel controls the engine throttle through the engine governor from low idle to maximum rpm. The second part of the lever's travel controls the output shaft speed setting. Under this arrangement, the lever's initial travel varies engine horsepower from that delivered at idle rpm to maximum horsepower at maximum governed engine rpm. The second part of the lever's travel varies the hoisting or road speeds, and any single setting of the lever maintains a fixed road speed up to the unit's maximum capacity regardless of the terrain.

The proper amount of speed droop* required for stability of the output shaft governor varies for each installation and depends upon the time constant** of the converter and the inertia behind the converter. The figure of 10 per cent is typical although it can run higher or lower. This means that if the no-load speed setting is set for 2000 rpm on the output shaft, full engine torque and converter output torque will be available when the output shaft drops to 1800 rpm. The installation, however, invariably influences the exact droop setting which should be most advantageous.



Typical governor quadrant.

*Droop is a per cent variation from full load to no-load rpm and is adjustable manually on the governor.

**Time constant is the time required for the output shaft to respond to a change of input power.

Twin Disc Clutch Company is the world's largest manufacturer of friction and fluid drives for industrial applications . . . and is the *only* manufacturer of *both* three-stage and single-stage torque converters. Because of the company's complete line of industrial products for applying and controlling the transmission of power, Twin Disc engineers can offer completely unbiased recommendations for solving your industrial drive problems.

TWIN DISC CLUTCH COMPANY
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Hydraulic Division, Rockford, Illinois

Circle 486 on Page 19

MACHINE DESIGN

November 14, 1957

Creativity or Conformity?

INDUSTRY gives little evidence of really wanting creativity. Where profit is the motive, doesn't conformity pay off more than creativity in the long run?

This is the bold challenge aimed at engineers and their companies by Dr. Richard Wallen, a psychologist, when addressing the Fourth Mechanisms Conference (Page 26) at Purdue last month.

His premise: Creativity involves rebellion, criticism of things as they are, nonconformity with the established order. But people and organizations recoil from such things and tend instead to value and reward conformity. Since most of us regard the attitudes of other people to be important in our lives, we fear ridicule or disapproval, put a lid on the bubbling pot of creativity, and conform.

This is reasonable. Blue-sky thinking all the time can make a fellow look like a "psychoceramic"—that's our first conventional reaction to this idea that we cut loose from the compulsion to be "acceptable."

However, this collision of opposing ideas need not occur. Seemingly, the method makes the difference. Conflict subsides if a sympathetic, and perhaps contributing, audience can be developed for the new idea. Several methods, all perhaps interlocked, seem to be available.

Have you ever known a master of the art of preselling? He conditions the people around him by proposing a bit at a time, leaving a period for acceptance before the next stage. The whole idea, springing forth full-grown from the head of its creator, is thus spared the contempt of his contemporaries. They have grown with the development, contributed to it, or moderated it constructively. They're sold—and the idea is often bigger or better.

Another method, proposed by Dr. Wallen, is utilization of the group approach, but for a different purpose from that so often intended. Sharing of knowledge, talents, and viewpoints is fine. But more fundamental, the better the people in a group personally know and understand each other, the less the fear of ridicule or disapproval, and the freer the exchange and acceptance of truly new ideas.

If we can make creativity an accepted factor in conformity, creativity need not be blocked by conformity.

Ben Hummel

ASSOCIATE MANAGING EDITOR

PATENT POOLS

By ALBERT WOODRUFF GRAY
Forest Hills, N. Y.

Patent pools and cross-licensing agreements are formed for several reasons: One man's invention may need another man's production facilities; or several patents combined may result in a new or better product. In these and similar cases the advantages are apparent, basically legitimate and recognized in patent statutes.

However, the monopoly inherent in patent ownership is not beyond need of restriction. The antitrust laws act as a governor to stabilize patent monopoly.

This article, by actual court cases and subsequent rulings, shows how the courts have drawn a boundary line between legal patent pooling and antitrust violation.

SEVERAL recent decisions illustrate efforts made by the courts to establish a principle of law that on one hand prohibits the formation of combinations tending to lessen competition, and on the other fosters the monopoly granted by statute to owners of patents.

Antitrust Law Violation

In the U. S. District Court in Michigan, suit was brought by the Federal Government against a patent holding company organized solely for the purpose of holding and licensing the use of patents contributed by its members. Interest in this patent pool was divided among five producers of power-driven machine tools.

Under "rules" of the pool, the manufacture and sale of machine tools was allocated—by specific types—to each member of the pool, and each member agreed not to manufacture the specific types of machines allocated to the other four members.

According to this agreement, each member of the company was entitled to an exclusive license of any patents or improvements in its particular field assigned to the organization. Furthermore, each member was obligated under the agreement to disclose and assign promptly to the pool all inventions and improvements it acquired on any of the machine tools.

The court held the conduct of this organization to be a violation of antitrust laws. Members were restricted in their manufacture of machine tools by being deprived of patent licenses in fields other than those which their production activities were confined. Invention and technological development were retarded. The producers were engaged in a conspiracy to unreasonably restrain interstate commerce in the manufacture of machine tools.[1]

Legal Patent Pools

In contrast with conclusions of the Federal Court in the above case, another and later instance emphasizes the difference between legal patent pools and those organized in violation of the Sherman Antitrust Act.

In an agreement made by two manufacturers of "cooling beds" used in the production of steel, each of the companies licensed to the other the use of specific patents, with the condition that the price set by each should be "fair and reasonable and comparable in general" to the prices established by the other company.

Here again, the Federal Government sued for an injunction against operation of the agreement, contending that the cross-licensing agreement was illegal and a violation of the antimonopoly statutes.

However, the Court held this pooling contract to be legal.

Quoting from an earlier decision, the Court declared, "Patent pools and cross licensing agree-

[1]References are tabulated at end of article.

ABOUT THE AUTHOR . . .

A regular contributor to MACHINE DESIGN on legal subjects, Albert Woodruff Gray draws upon a broad background of first-hand experience with the law and its practice, spanning a number of years. A native of New England, Mr. Gray is a graduate of New York Law School. He was a practicing lawyer for 25 years, representing several prominent manufacturing companies. Later, he served for four years as attorney and legal adviser on advertising copy and radio scripts for a large advertising agency, followed by another period of four years as editorial tax writer for a publishing concern. He retired from active practice in 1947 to devote his time to writing, and has been the author of a large number of magazine articles, as well as two books.

ments, when formed in a legitimate manner for legitimate purposes, are not illegal in themselves. It is only where the agreements are used to effect a restraint of trade or a monopoly that they violate the law, as where they are used to fix prices or to suppress competition from unpatented articles or to monopolize an entire industry by pooling the dominating patents and allocating fields of manufacture among companies which would otherwise be in competition."

Then in outline of the legal and permissible boundaries of the monopoly conferred by the patent laws, the court added, "It must be remembered that patent laws give the patentee a monopoly. He may make, use or sell the patented product, license others on an exclusive or nonexclusive basis to do so; authorize the issuance of sublicenses, or assign the patent itself for a consideration.

"The sole limitation is that he must not use his legitimate patent monopoly as a means of suppressing competition or acquiring a monopoly outside of the area of monopoly which the patent grants. The legality of the agreements in this case depends therefore upon a comparison of the competitive situation created by the patent monopolies which each party would have in the absence of the agreement.

"It is consistent with the spirit as well as the letter of the patent laws that each of these two companies should arrange to use the other in order to reap the awards to which each is entitled as patentee and yet which it is in no position to reap by itself."[2]

Boundary Line Decisions

Between the pooling of patents and licenses for the use of inventions in a legitimate business procedure, and activities directed toward price fixing and evasion of the antitrust laws, two decisions of the United States Supreme Court have clearly run a boundary line.

Restraint of Trade: In one of these instances, a suit had been brought involving patents covering the manufacture of wrinkle finish enamels. Settlement of the controversy was made by organizing a corporation, with the stock to be shared equally by the contending manufacturers. To this newly organized company each of these manufacturers assigned all of its wrinkle enamel patents.

Other producers subsequently shared in the plan. Ultimately, the new corporation not only dispensed licenses for the use of these patents, but also stipulated the price at which the products should be marketed. An important section of the agreement governing functions of this patent pool stated:

"The licensor hereby reserves and shall have the right at any time to establish a schedule of minimum prices, discounts, and selling terms only in accordance with which licensee, licensor and all

other licensees shall thereafter sell or otherwise dispose of products covered by patents included herein . . ." The licensor further reserved the right to modify, amend and suspend any such schedule and/or establish a new schedule at any time.

"The licensor announces as a matter of policy that it will fix said price based upon the cost of all materials and labor as reported by the United States Department of Commerce and the United States Department of Labor, plus the royalty charged hereunder, it being the intent and purpose of the licensor to open to the entire trade the use of these patents so licensed, at the least price consistent with a reasonable profit to the manufacturer."

With these altruistic motives the corporation issued from time-to-time its license rulings giving the minimum prices, terms and conditions to be followed by the licensees.

On these facts the Federal Government brought suit against the corporation charging that a conspiracy existed to fix uniform minimum prices and substantially limit competition by means of these licensing agreements.

When the controversy came before the Supreme Court, it was said in decision, "The United States charges the use of patent licenses as an essential part of the plan to restrain trade . . . in enamels, varnishes and paints; (trade) that is alleged to be and obviously is interstate in character. It charges that the price control is an essential part of that constraint.

"We think it beyond question that the making of license contracts for the purpose of regulating distribution and fixing prices of commodities in interstate commerce is subject to the Sheman (anti-trust) Act even though the isolated act of contracting for the licenses is held within a single state.

"Two or more patentees in the same patent field may not legally combine their valid patent monopolies to secure mutual benefits for themselves through contractual agreements between themselves and other licensees for control of the sale price of the patented device."[3]

License Royalties: On the other side of this boundary line are the instances in which the end of such pooling agreements is merely the collection of royalties.

Suit was brought in an instance of this character by an electronics firm charging infringement on a new type of synchronizing system for television receivers. In defense, the infringer contended that the firm, by virtue of its pool of approximately 600 patents for which it collected royalties from various licensees, was misusing these patents.[4]

In granting an injunction on behalf of the electronics company, owner of this patent pool, the court cited as authority the defense to a previous suit brought by the same company for royalties due it under a patent license.

In that suit the licensee had asserted in its defense that the owner of this patent pool was engaged, "in an illegal endeavor to eliminate all competition and secure an unlawful monopoly . . . and that in its execution of this plan it had acquired approximately 425 United States letters patent and approximately 120 applications for United States letters patent from its employees," and from other corporations and persons.[5]

These license agreements permitted the company to use in the manufacture of its products any or all of the patents held in this pool or those to which it might acquire rights. In return the company agreed to pay a royalty based upon a small percentage of the selling price of radio receivers, with a minimum of $10,000.

In sustaining the legality of this patent pool, the Supreme Court declared: "The mere accumulation of patents, no matter how many, is not in and of itself illegal. We cannot say that payment of royalties according to an agreed percentage of the licensee's sales is unreasonable. Sound business judgment would indicate that such payment represents the most convenient method of fixing the business value of the privileges granted by the licensing agreement.

"We are aware that convenience cannot justify an extension of the monopoly of the patent. But as we have already indicated, there is in this royalty provision no inherent extension of the monopoly of the patent."

Furthermore, the Court added: "The licensee cannot complain because it must pay royalties whether it use these patents or not. What it acquired by the agreement into which it entered was the privilege to use any or all of the patents and developments as it desired to use them. If it chooses to use none of them it has nevertheless contracted to pay for the privilege of using existing patents plus any developments resulting from the patent owner's continuous research.

"We hold that in licensing the use of patents to one engaged in a related enterprise, it is not in itself a misuse of patents to measure the consideration by a percentage of the licensee's sales."[6]

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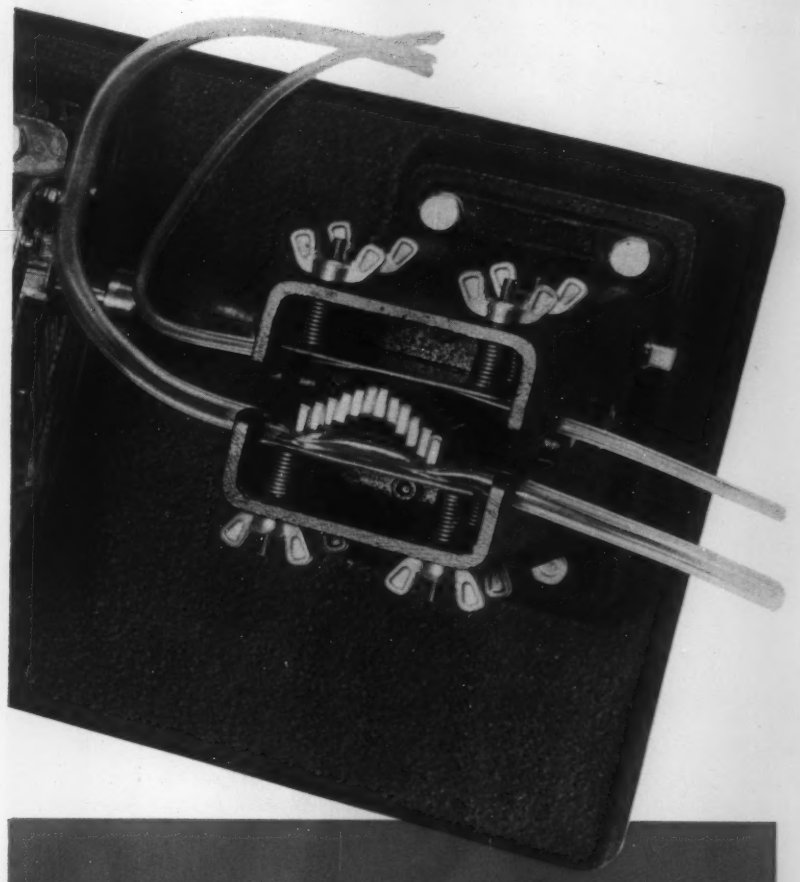
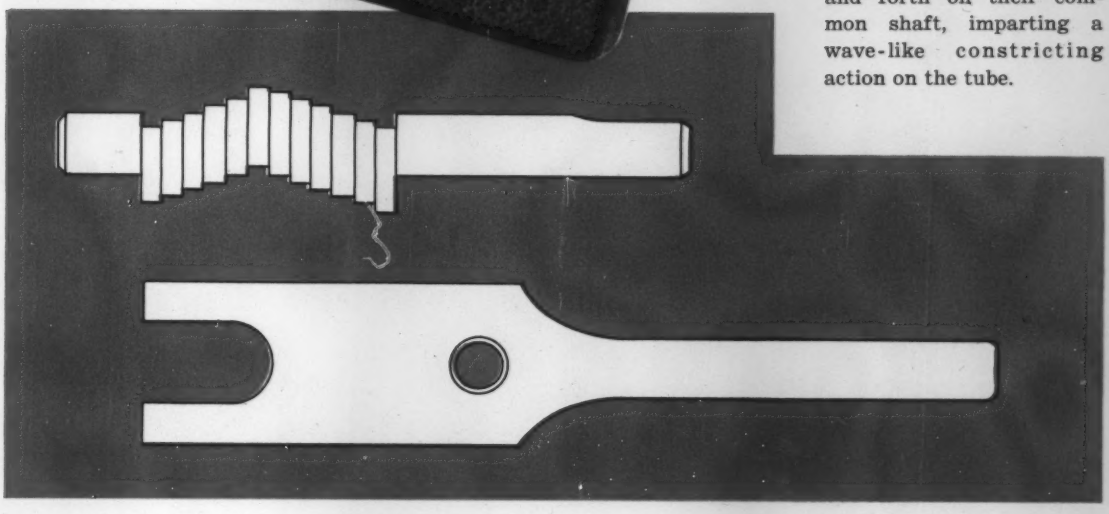
2. United States v. Birdsboro Steel Foundry & Machine Co., 139 *F.S.* 244, Pennsylvania, March 1, 1956.
3. United States v. New Wrinkle, Inc., 242 *U.S.* 350, Ohio, February 4, 1952.
4. Hazeltine Research v. Avco Manufacturing Co., 227 *Fed.* 2d 137, Illinois, October 31, 1955.
5. Automatic Radio Mfg. Co. v. Hazeltine Research, 176 *Fed.* 2d 799, Massachusetts, August 22, 1949.
6. Automatic Radio Mfg. Co. v. Hazeltine Research, 339 *U.S.* 827, Massachusetts, June 5, 1950.

"Management is sometimes prone to feel that it generates the really top-notch ideas, with the role of the bench worker primarily that of carrying out our suggestions. There is no monopoly on creativity. Good ideas can and do come from many sources."—EMIL OTT, *director of research, and* CARL PRUTTON, *executive vice president, Food Machinery and Chemical Corp.*

scanning the field for *ideas*



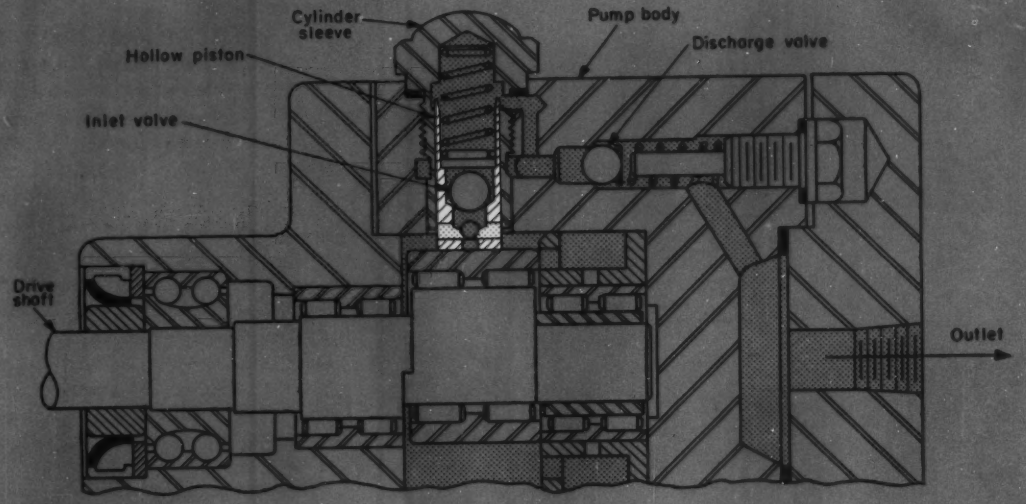


Kneading motion of cam-driven fingers achieves progressive closing and opening of flexible tube to produce positive pumping action. The pump, developed by Sigmamotor Inc., has a group of closely spaced fingers mounted on a common shaft. One end of each finger is slotted to fit over an eccentric on a drive shaft, and the opposite end of the finger is in contact with the tube containing the liquid.

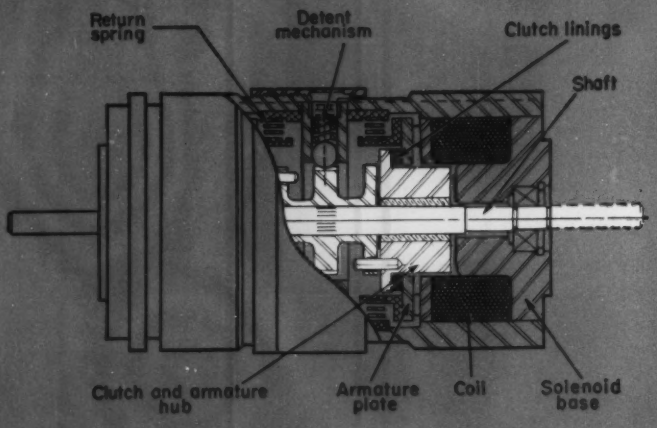
The eccentrics on the drive shaft are each in a different plane, arranged so that the planes of adjacent eccentrics are rotated progressively around the drive shaft. Rotation of the drive shaft causes the fingers to rotate back and forth on their common shaft, imparting a wave-like constricting action on the tube.

Expansion of hollow piston under high pressure provides sealing action against the cylinder wall, preventing fluid leakage. In a hydraulic pump developed by Simplex Engineering Co., a cup-shaped piston design with thin side walls is used. Pressure is applied to the fluid as the open end of the piston is forced into the fluid-filled cylinder sleeve. Leakage is eliminated by expansion of the piston skirt against the cylinder-sleeve wall as pressure builds up.

Reciprocation of the piston is provided by a camshaft eccentric, bearing against the solid head of the piston, and a spring fitted into the hollow end of the piston. The spring is compressed during the pressure stroke, while the fluid is forced out through holes in the cylinder sleeve and past a discharge valve. The inlet valve is in the piston head.



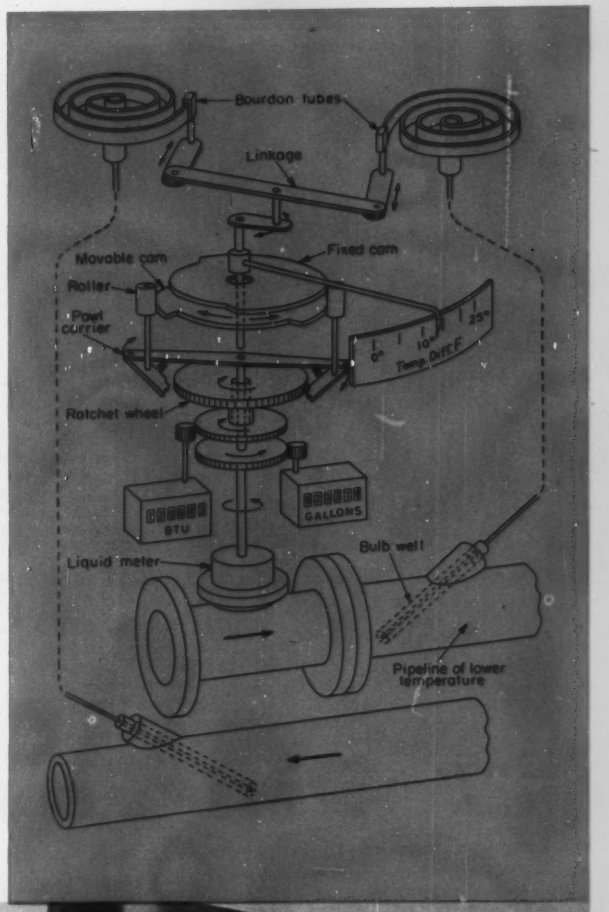
Magnetic rotational indexing of shaft permits adjustable control of amount and direction of shaft rotation. In a stepping motor developed by G. H. Leland Inc., a clutch plate and detent mechanism is mounted between two rotary solenoids whose armature plates face each other. The shaft-mounted clutch plate rotates with either of the energized armatures by magnetic attraction.

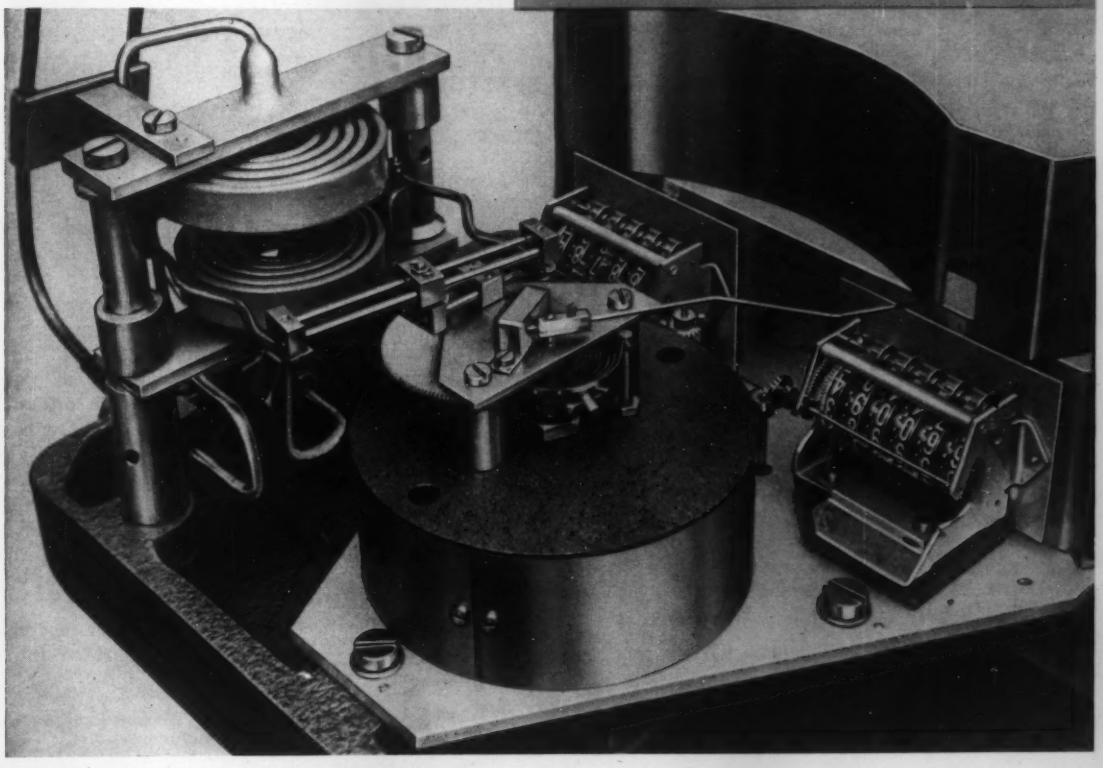


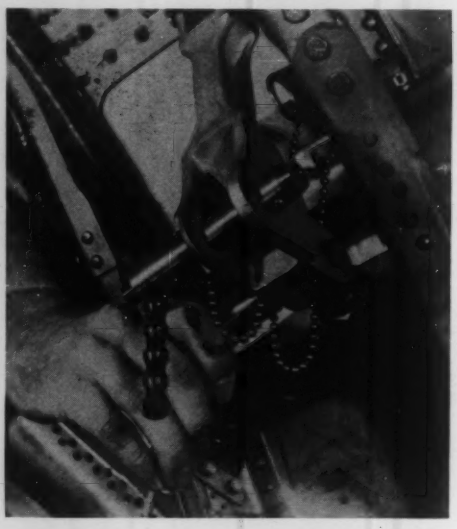
Amount of shaft rotation is dependent upon duration of solenoid input current. When the solenoid is de-energized, the armature returns to its original position, but the clutch plate and shaft are held in the indexed position by a spring-loaded ball detent mechanism.

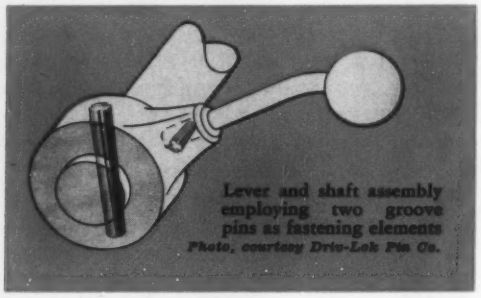
Mechanical integration continuously produces the product of one variable and the difference between two other variables in an all-mechanical Btu meter developed by Air Conditioning Equipment Corp. Two thermocouples in different pipelines cause two bourdon tubes in the meter to deflect. A linkage between the two bourdon tubes has a connection at its midpoint that moves in relation to the difference in deflection (temperature) of the two tubes—the heat loss between the two pipelines.

Liquid flow within the supply pipeline is measured with a flow meter. The liquid meter drives a pawl carrier at a rotational speed corresponding to the rate of fluid flow. Pawls on the carrier engage a ratchet wheel over an angle of rotation that represents the temperature differential. This is accomplished by two disc cams, one fixed and one that rotates in proportion to the temperature differential as supplied by the linkage joining the bourdon tubes. The pawls are engaged and disengaged by rollers that are in contact with the cam surfaces. The ratchet wheel is thus rotated by the pawls in increments determined by the heat loss, at a rate determined by the fluid flow. The ratchet wheel operates a Btu meter.









Lever and shaft assembly employing two groove pins as fastening elements
Photo, courtesy Driv-Lok Pin Co.

Mount design for North American F-100 Super Sabre jet engine. Single-acting quick-release pin in blind location provides positive locking action but can be instantly released by pulling back handle or depressing release button to permit fast engine removal and replacement
Photo, courtesy D. W. Price Corp.

Design Guide

Pin Fasteners

Part 1—Semipermanent Assembly

By LEO F. SPECTOR
Associate Editor
MACHINE DESIGN

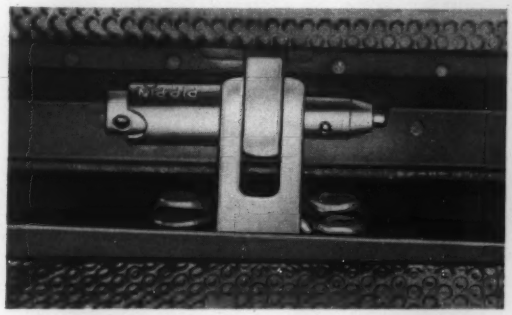
Simple in form, pin fasteners offer a neat, effective approach to assembly where loading is primarily in shear. A number of pin devices have been developed to meet a wide range of varying application and assembly requirements. As an aid in design decisions, Machine Design presents this two-part comprehensive guide to selection and application of specific pin-fastener types. This first article covers fasteners for semipermanent assembly. Quick-release types will be examined in a second future article.

PIN fasteners represent one of the basic mechanical methods for joining parts. Traditional forms such as taper, dowel, and clevis pins, which were intended as locating surfaces, are among the oldest fastening elements in use, and are still finding valid application in certain assembly functions. Today, however, greatest potential in design for fastening service is offered by a group of pin devices, that are of more recent origin.

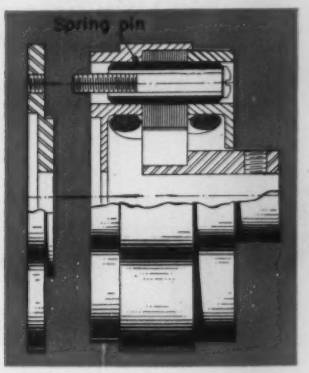
Although all of these fasteners are characterized by the inherent simplicity of the pin form, details of design and construction vary widely. Range of application possibilities is depicted in the accompanying illustrations of representative pin fastener assemblies.

As a basis for preliminary analysis in design, pin fasteners can be conveniently separated into two functional groupings:

1. Semipermanent assembly
2. Quick-release attachment



Hinge-type attachment for large ventral access door on Navy's Douglas F4D aircraft. Double-acting, quick-release pin provides positive locking action but can be easily driven in or out of fittings for fast door removal and replacement
Photo, courtesy Aviation Developments Inc.



Allard synchronous brake design which uses spring pins to hold three main stator parts together and also to act as a guide bushing for assembly of long mounting screws
Drawing, courtesy Elastic Stop Nut Corp. of America

Spark-wheel assembly of Ritepoint cigarette lighter using light-duty spring pin as combination axle and fastener element
Photo, courtesy Standard Pressed Steel Co.

- **Basic Forms**
- **Selection Factors**
- **Design Practices**
- **Production Considerations**

The first group consists of those pin fasteners that require application of pressure or the aid of tools for installation or removal. Representative types include the various grooved-surface and spring pins, as well as conventional taper, dowel, clevis, and cotter pins.

The second category identifies the more elaborate self-contained pin devices which have been developed for rapid manual assembly or disassembly. With the exception of one quick-release "cotter-pin" design, these pin types all employ some form of detent mechanism to provide a locking action in assembly.

Each of these groups will be presented in detail in this two-part series of articles. Attention will be given to the various types of pin fasteners available and the factors influencing their selection and application for solution of specific design problems. Fasteners for semipermanent assembly are discussed in this article; quick-release types will be treated in a later article.

Pins classified for semipermanent assembly are perhaps the simplest mechanical fastening devices. They are ideally suited for applications where loading is primarily in shear and only small or negligible clamping force is required. Often, substantial advantages in the way of cost and convenience of assembly can be realized in design.

As a general rule, these pins are reusable and can be removed and reassembled without damage to mating parts or without appreciably affecting the function of the pin. All of these pin types can be readily adapted for use as a permanent fastener, but are usually employed where infrequent assembly and disassembly are anticipated.

Two basic types of pins offer potential application as semipermanent fastener elements:

1. Machine pins
2. Radial-locking pins

Machine Pins: A number of pin forms have been standardized by ASA under the designation of machine pins (*American Standard Machine Pins*—ASA B5.20-1954). Although all of these standard pin forms can be adapted to fastening service, attention will be given here only to those types generally considered to be the most important for this purpose. They include hardened-and-ground dowel pins, taper pins, and clevis and cotter pins.

DOWEL PINS: Chamfered on one end with a crown on the other, Fig. 1, the hardened-and-ground dowel pin is a high-quality part manufactured to exacting requirements. Two dimensional series

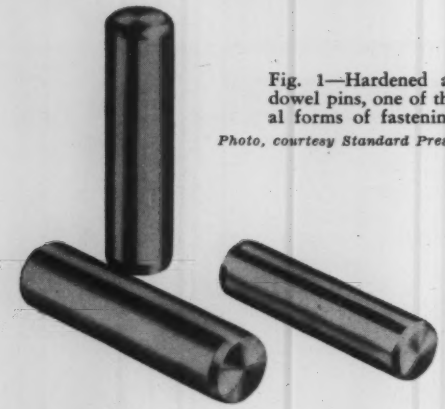


Fig. 1—Hardened and ground dowel pins, one of the traditional forms of fastening elements.
Photo, courtesy Standard Pressed Steel Co.

of pins have been standardized in nominal diameters ranging from ⅛ to ⅞ in. Standard pins are 0.0002 in. oversize on the nominal diameter; oversize pins are 0.001 in. oversize. Pins of larger diameter, as well as other oversize dimensional series, are also available from certain manufacturers.

Standardized pin lengths vary with nominal diameter, ranging from a minimum of ½ in. (⅛ in. size) to a maximum of 5½ in. (⅞ in. size). Nonstandard lengths are also available from most manufacturers.

Standard tolerance on all pin diameters is ±0.0001 in. A typical manufacturer's specification for such pins is: Material, heat-treated alloy steel; surface hardness, Rockwell C 60-62; core hardness, Rockwell C 50-54; surface finish, 6 mu in. max; and average single-shear strength, 150,000 psi.

For assembly of these pins, a press or tap fit into reamed holes is recommended. In practice, however, the secondary reaming operation is often omitted where production requirements, cost considerations, accuracy or material specifications for mating parts do not justify the refinement.

Although considered to be basically locating surfaces, these precision dowel pins are useful in several fastening functions. Typical possibilities include:

1. Holding laminated sections together with surfaces either drawn up tight or separated in some fixed relationship.
2. Fastening machine parts where accuracy of alignment is a primary consideration.
3. Locking components on shafts, in the form of a transverse pin key, where a secure, high-strength joint with minimum stress concentration under severe torque loads is desired.

In addition, these pins can be used for combination functions as a locking fastener and hinge, wrist pin, or small stub shaft in moving parts.

TAPER PINS: Wedging action developed by a taper pin in a force-fit assembly offers a natural clamping force for fastening and joining parts. Typical taper-pin assembly of two cylindrical members is shown in Fig. 2.

Standard pins have a taper of ¼ in. per ft, measured on the diameter. Basic dimension is the diameter of the large end. Diameter d of the small end is given by $d = D - 0.02083L$ where D = diameter of large end, in., and L = pin length, in.

A series of numbered pin sizes has been standardized, ranging from No. 7/0 (0.0625 in. large end) to No. 10 (0.7060 in. large end). Standard lengths for these pins, depending on diameter of large end, vary from ⅜ to 6 in. Full range of manufactured sizes includes No. 8/0 (0.047-in. large end) to No. 14 (1.523 in. large end) in standard and nonstandard lengths.

Two manufactured grades are recognized: Commercial type, without a concavity tolerance, in sizes 7/0 to 14 and Precision type, with a concavity tolerance, in sizes 7/0 to 10. Available pin materials include mild, stainless and alloy steel and brass.

Holes for taper pins are customarily sized by reaming. Typical specification for a through hole formed by step drills and straight fluted reamers is shown in Fig. 2. Present trend, however, is toward the use of helically fluted taper reamers which provide more accurate sizing and require only one drilling operation to produce a pilot hole the size of the small end of the taper pin.

To provide a tight fit, the taper pin is usually driven into the hole until it is fully seated. Taper of the pin aids hole alignment in assembly and also facilitates pin removal.

A simple, low-cost fastener element, standard taper pins have been widely used for light-duty service in the attachment of wheels, levers, and similar components to shafts. Torque capacity of the pin in such assemblies is usually determined on the basis of double shear, using the average diameter along the tapered section in the shaft for area calculations.

Several modifications of the basic taper pin form have also been developed to meet nonstandard design situations. For joints where a slotted construction is employed for assembly, a taper pin milled flat along one surface provides an effective wedge fastener for locking the members securely. In blind or open locations where access to either end of the taper pin is blocked or difficult, a threaded section may be incorporated in the accessible end for assembly of a nut, bolt, or stud to facilitate pin installation or removal. Both external and internal-thread designs are available from manufacturers. Other common modifications

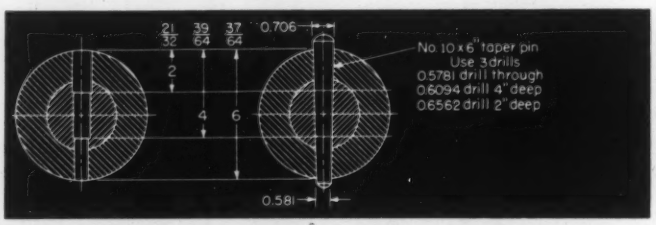


Fig. 2—Assembly of two cylindrical parts with taper pin showing standard specification for through hole produced by step drills and straight fluted reamers. Specification details are based on recommendations given in *American Standard Machine Pins*—ASA B5.20-1954. Present trend is toward the use of helically fluted taper reamers which require only one drilling operation to provide a through pilot hole the diameter of the small end of the taper pin.

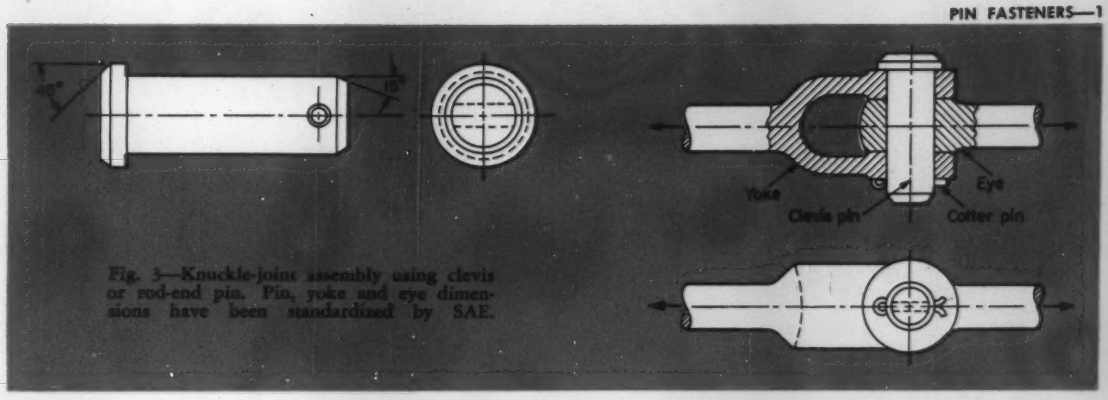


Fig. 3—Knuckle-joint assembly using clevis or rod-end pin. Pin, yoke and eye dimensions have been standardized by SAE.

include special head shapes and split-end constructions.

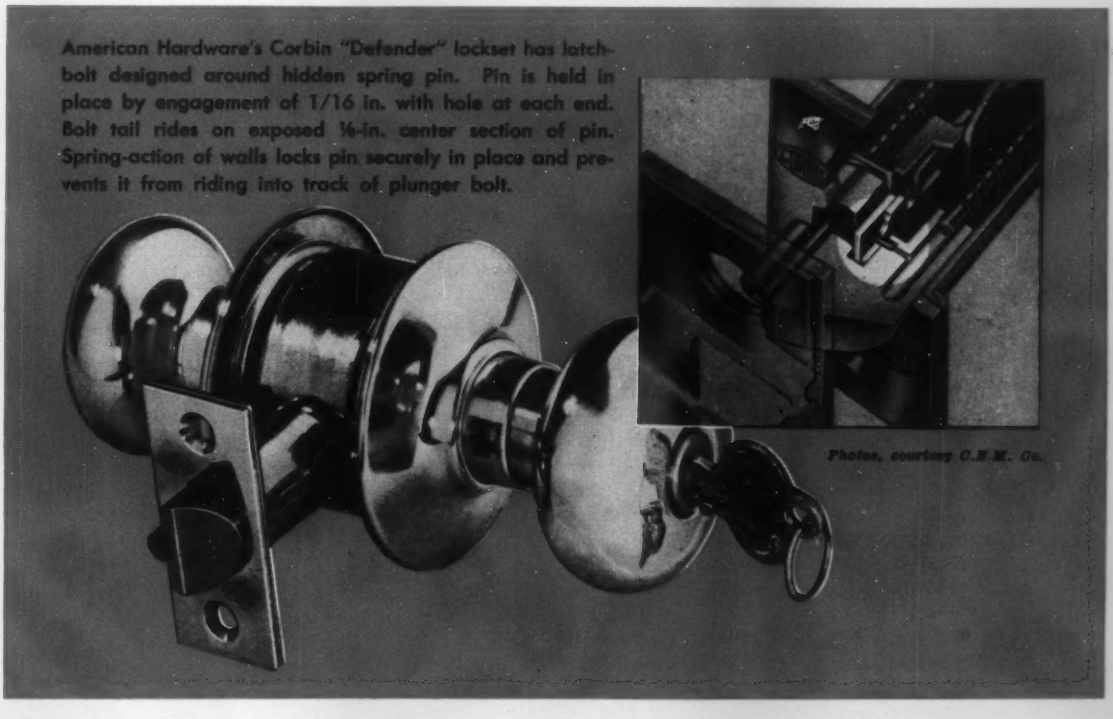
As a guide to selection of taper pins for pin-key applications in shafts, the equivalent taper pin sizes listed in Table 1 for different shaft sizes should be adequate under normal service and load conditions. These recommended sizes are based on maximum practical hole-to-shaft-diameter relationships and should not be exceeded to avoid weakening the shaft. As a rule of thumb, the diameter (large end) of the pin should be about ¼ the shaft diameter for good proportions.

CLEVIS PINS: A special-purpose fastener developed for knuckle-joint assemblies, Fig. 3, the clevis, knuckle, or rod-end pin is used to connect two rod members under tensile or compressive loads. Conventional form of the pin—headed at one end, with a cotter-pin hole at the other chamfered end—has been standardized by the SAE for automo-

Table 1—Recommended Assembly Practices for Radial-Locking Pins

Shaft Diam (in.)	Transverse Key: Pin Diam (in.)	Transverse Key: Taper Pin No.	Longitudinal Key: Pin Diam (in.)
3/16	1/16	7/0	...
7/32	5/64	6/0	...
1/4	3/32	5/0	1/16
5/16	7/64	4/0	5/64
3/8	1/8	3/0	3/32
7/16	5/32	0	1/8
1/2	5/32	0	1/8
9/16	3/16	2	5/32
5/8	3/16	2	5/32
11/16	7/32	3	3/16
3/4	1/4	4	3/16
13/16	1/4	4	...
7/8	1/4	4	7/32
15/16	5/16	5	1/4
1	5/16	6	1/4
1 1/16	5/16	6	...
1 1/8	3/8	7	...
1 3/16	3/8	7	...
1 1/4	3/8	7	5/16
1 5/16	7/16	7	...
1 3/8	7/16	7	3/8
1 7/16	7/16	7	...
1 1/2	1/2	8	7/16

American Hardware's Corbin "Defender" lockset has latch-bolt designed around hidden spring pin. Pin is held in place by engagement of 1/16 in. with hole at each end. Bolt tail rides on exposed ⅛-in. center section of pin. Spring-action of walls locks pin securely in place and prevents it from riding into track of plunger bolt.



Photos, courtesy C.H.M. Co.

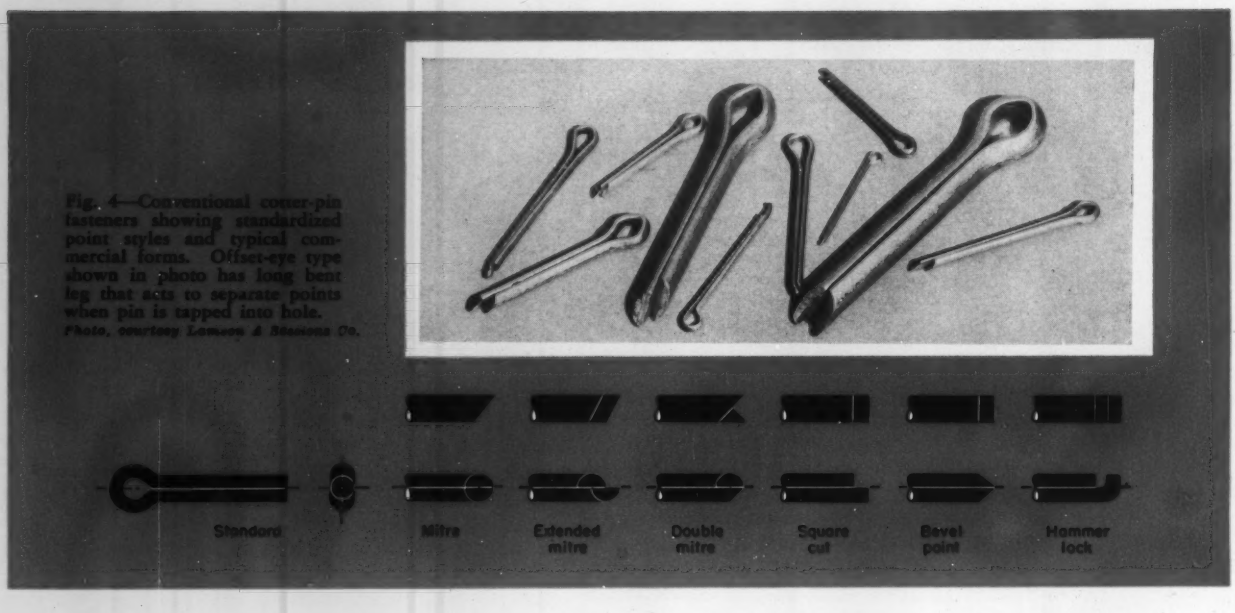


Fig. 4—Conventional cotter-pin fasteners showing standardized point styles and typical commercial forms. Offset-eye type shown in photo has long bent leg that acts to separate points when pin is tapped into hole. *Photo, courtesy Lamson & Sessions Co.*

tive application since 1915. Dimensions of these pins conform to those of SAE standard adjustable and plain yokes and eyes.

Standard nominal diameters for clevis pins range from 3/16 to 1 in. Corresponding shank lengths vary from 19/32 in. for 3/16-in. size to 2⅝ in. for 1-in. size. Standard material is steel, either soft or cyanide-hardened to meet service conditions.

Basic function of the clevis pin is to connect mating yoke, or fork, and eye members in knuckle-joint assemblies. Held in place by a small cotter pin or other similar fastening means, it provides a mobile joint construction which can be readily disconnected for adjustment or maintenance.

In addition to the standard pin forms, several designs have been developed to meet special assembly and service conditions. Common modifications include slotted and noncircular-head constructions as well as threaded ends for assembly with standard nuts or into internal thread sections tapped into one of the yoke arms.

Design of conventional pin elements for knuckle-joint assemblies represents a classic engineering problem and has received considerable attention in the literature. Theoretically, in the ideal joint the length of pin in each arm of the yoke should be equal to half that in the eye member. This relationship is based on equal strengths in failure for the different elements and modes of failure of the knuckle joint. In practice, however, the yoke-arm dimension is usually made greater than this proportion to minimize spreading of the yoke under load. This spreading action imposes additional bending load on the pin, reducing its effective strength.

COTTER PINS: One of the oldest fastener forms, the split cotter pin is characterized by its simplicity and reliability. In assembly, the pin is merely inserted in a hole and locked in place by spreading the split ends. Result is a secure retaining shoulder or an antirotation device for holding parts in place on threaded or unthreaded members.

Standard cotter pins are made from half-round wire formed into the shape of a split cylindrical pin with a loop at one end. A series of 18 sizes has been standardized in nominal diameters ranging from 1/32 to ¾ in. Available materials include mild steel, brass, bronze, stainless steel, and aluminum. Some leeway is permitted in head-loop design; however, inside diameter of the loop is usually the same as pin diameter. Point styles standardized by ASA and SAE are shown in Fig. 4.

Basically, the cotter pin is a locking device for other fasteners. Used with a castle or slotted nut on bolt, screws, or studs, it provides a convenient,

Table 2—Recommended Assembly Practice for Standard Cotter Pins

Nominal Thread Size (in.)	Nominal Cotter Pin Size (in.)	Cotter Pin Hole (in.)	End Clearance* (in.)
1/4	1/16	5/64	7/64
5/16	5/64	3/32	7/64
3/8	3/32	7/64	9/64
7/16	3/32	7/64	11/64
1/2	1/8	9/64	11/64
9/16	1/8	9/64	13/64
5/8	5/32	11/64	15/64
3/4	5/32	11/64	17/64
7/8	5/32	11/64	9/32
1	3/16	13/64	5/16
1 1/8	3/16	13/64	25/64
1 1/4	7/32	15/64	13/32
1 3/8	7/32	15/64	7/16
1 1/2	1/4	17/64	31/64
1 5/8	1/4	17/64	31/64
1 3/4	5/16	5/16	35/64
1 7/8	5/16	5/16	35/64
2	5/16	5/16	41/64
2 1/4	5/16	5/16	41/64
2 1/2	3/8	3/8	3/4
2 3/4	3/8	3/8	3/4
3	1/2	1/2	3/4

*Distance from extreme point of bolt or screw to center of cotter pin hole.

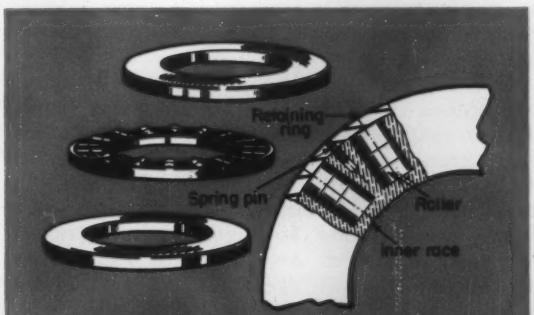
low-cost locknut assembly. SAE recommended practice in such assemblies for a range of nominal nut and screw thread sizes appears in Table 2.

Another common application of the cotter pin, as mentioned previously, is to hold standard clevis pins in place. It can also be used with or without a plain washer as an artificial shoulder to lock parts in position on unthreaded or threaded rods and shafts.

Several variations of the basic cotter pin form have been developed for special design requirements. One modification for quick-release attachment will be discussed later. Another type, Fig. 4, has an offset eye and a long leg bent inward at the end to facilitate assembly. When the pin is inserted in a hole and tapped with a hammer to center the eye the tip of the shorter leg is driven against the offset of the longer leg and separated.

A third form, developed for use with clevis pins, has one prong bent into hump shape. When the straight prong is inserted into the mounting hole, the bent prong snaps around the outer opening of the hole to lock the cotter pin in place. With this construction, the cotter pin can be readily removed and reinserted without an additional bending operation on the prongs.

Radial-Locking Pins: Low cost, ease of assembly, and high resistance to vibration and impact loads are common attributes of a group of commercial pin devices designed primarily for semipermanent fastening service. Two basic pin forms are employed: Solid with grooved surfaces, and tubular.



Outside retaining ring of the Rollway Type "T" thrust bearing must be securely fastened and yet permit easy removal for possible correction of rollers after assembly. Original design employed set screws which required separate drilling and tapping operations as well as special assembly procedure. Now, the ring is positioned with six spring pins. To remove the ring, the pins are pushed into oversize holes drilled in the inner race. With the ring free, the pins drop out and can be reused.

Drawings, courtesy Binetic Stop Nut Corp. of America

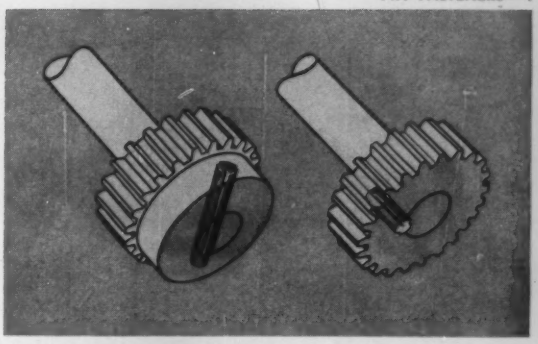


Fig. 5—Transverse and longitudinal key assemblies employing radial-locking pin fasteners. Type A groove pins are used in both applications.
Photo, courtesy Driv-Lok Pin Co.

In assembly, radial forces produced by elastic action at the pin surface develop a secure, frictional locking grip against the hole wall.

In addition to the frictional locking action, several other desirable characteristics of these pin fasteners stem from the resilient surface construction. All of these pins are reusable and can be removed and reassembled many times without appreciable loss of fastening effectiveness. Live spring action at the pin surface also prevents loosening under shock and vibration loads.

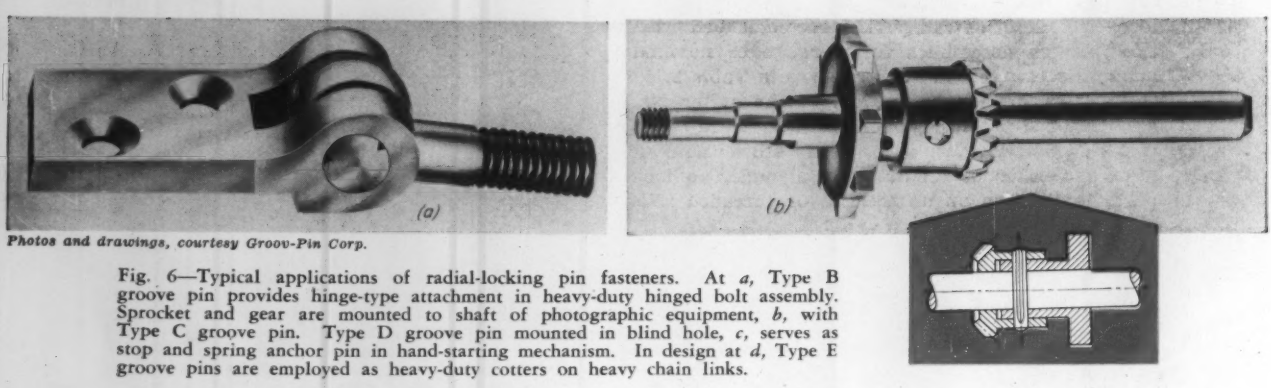
Need for accurate sizing of holes is eliminated since the pins can accommodate a range of variation. Holes drilled to standard production tolerances are usually adequate. Either machine or manual assembly is possible, and the pins can be readily adapted to automatic processing methods for high-speed production.

Representative applications of these pin fasteners are shown in Fig. 5 and 6. Recommended practices for specification of different pin forms in pin-key applications are given in Table 1. Pin diameters listed are maximums for the particular shaft sizes. Although these data represent recommendations of specific manufacturers, they are based on shaft strength considerations and offer a general guide to good design proportions with all types of pin fasteners.

GROOVED STRAIGHT PINS: Locking action of the groove pin is provided by parallel, longitudinal grooves uniformly spaced around the pin surface. Conventional practice is to use three grooves; however, details of pin design vary with manufacturers. Rolled or pressed into solid pin stock, the grooves act to expand the effective pin diameter. When the pin is driven into a drilled hole corresponding in size to nominal pin diameter, elastic deformation of the raised groove edges produces a secure force-fit with the hole wall.

Five groove constructions have been standardized by the SAE, Fig. 7. Standard pin sizes cover a range of nominal diameters from 3/64 to ½ in. in varying lengths from ⅛ to 4½ in. Standard materials include cold-drawn SAE 1112 and 1113 steel, alloy steel, stainless steel, and copper alloy.

Type A pin, which has grooves running the full



Photos and drawings, courtesy Groov-Pin Corp.

Fig. 6—Typical applications of radial-locking pin fasteners. At *a*, Type B groove pin provides hinge-type attachment in heavy-duty hinged bolt assembly. Sprocket and gear are mounted to shaft of photographic equipment, *b*, with Type C groove pin. Type D groove pin mounted in blind hole, *c*, serves as stop and spring anchor pin in hand-starting mechanism. In design at *d*, Type E groove pins are employed as heavy-duty cotters on heavy chain links.

length, is used for general-purpose fastening.

Type B pin has grooves extending half the length of the pin. It serves primarily as a hinge or linkage "bolt" but also can be employed for other functions in through-drilled holes where a locking fit over only part of the pin length is required.

Type C pin has full length grooves with a pilot section at one end to facilitate assembly. Expanded dimension of this pin is held to a maximum over the full grooved length to provide uniform locking action. It is recommended for applications subject to severe vibration or shock loads where maximum locking effect is required.

Type D pin has reverse tapered grooves extending half the pin length. It is the counterpart of the Type B pin for assembly in blind holes.

Type E pin has a half-length groove section centered along the pin surface. It can be used as a cotter pin or in similar functions where an artificial shoulder or a locking fit over the center portion of the pin is required.

In addition to these standard types, a wide range of nonstandard constructions is offered by manufacturers. Design options include modified pin shapes and groove arrangements, nonstandard sizes, and special materials and heat treatments. One common type, which is ideally suited for hopper or automatic feeding, has a short pilot section at each end to eliminate the need for pin orientation in assembly.

Table 3—Torque and Power Ratings for Groove Pins*

Shaft Size (in.)	Nominal Pin Diam (in.)	Torque Rating (lb-in.)	Power Ratings At 100 rpm (hp)
3/16	1/16	4.6	0.007
7/32	5/64	8.4	0.013
1/4	3/32	13.7	0.022
5/16	7/64	23.6	0.038
3/8	1/8	37.2	0.060
7/16	5/32	67.6	0.108
1/2	5/32	77.2	0.124
9/16	3/16	125	0.200
5/8	3/16	139	0.222
11/16	7/32	207	0.332
3/4	1/4	297	0.476
13/16	1/4	322	0.516
7/8	1/4	347	0.555
15/16	5/16	580	0.927
1	5/16	618	0.990
1 1/16	5/16	657	1.05
1 1/8	3/8	1010	1.61
1 3/16	3/8	1065	1.70
1 1/4	3/8	1120	1.79
1 5/16	7/16	1590	2.55
1 3/8	7/16	1670	2.67
1 7/16	7/16	1740	2.79
1 1/2	1/2	2380	3.81

*Data, courtesy Driv-Lok Pin Co. Torque and power ratings are based on pins of B 1112 steel under double shear; assuming a safety factor of 8.

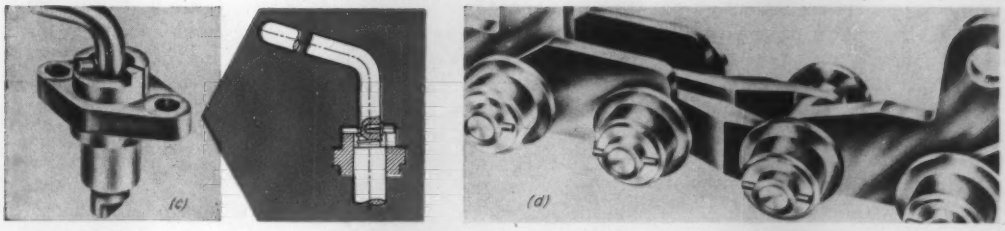
For standard groove pins made of B 1112 steel, load capacity in single shear varies from about 110 lb for 3/64 in. size to 12,800 lb for ½ in. size. Typical torque and horsepower ratings for pins employed as transverse keys in shafts are given in Table 3. These data are based on pins of B 1112 steel under double-shear loading. A safety factor of 8 is assumed.

Locking force developed by a groove pin in assembly is a function of pin diameter and effective length of engagement. As either one or both of these variables are increased, holding action, along with forces required for pin insertion and removal, are increased.

Best results under average assembly conditions are obtained with holes drilled the same size as the nominal pin diameter. Undersize hole specifications should be avoided. This practice can lead to deformation of the pin in assembly, damage to hole walls, and shearing-off of the raised groove edges, thus reducing holding action and preventing reuse of the pin. Also, when the part material is appreciably harder than that of the pin, chamfered or rounded hole edges should be specified to avoid shearing of the expanded pin section.

Recommended hole tolerances for groove pins are depicted graphically in Fig. 8. These values, which are added to the basic hole diameter (nominal pin diameter), apply generally to steel pins where the ratio of engaged length to diameter is not less than 4:1 or more than 10:1 and a strong locking action is desired. As the length-diameter ratio decreases, tolerances become more critical and should be held closer than the chart values, as governed by severity of locking requirements. Conversely, with increasing ratio values and less severe locking requirements, hole tolerances given by the chart may be increased as much as 50 per cent.

SPRING PINS: Resilience of hollow-cylinder walls under radial compression forces is the principle of two pin forms developed for fastening application.



One design employs spiral-wound metal strip, Fig. 9*a*, to achieve almost a coil-spring effect. The other has the shape of a slotted tube, Fig. 9*b*, to provide the desired resilient wall action. Both pin forms are made to controlled diameters greater than the holes into which they are pressed. Compressed when driven into the hole, the pins exert spring pressure against the hole wall along their entire engaged length to develop a strong locking action.

SPIRAL-WRAPPED PINS: Standard sizes of these pins cover a range of nominal diameters from 1/32 to ½ in. in lengths from ⅛ to 4 in. Standard materials are heat-treated 1070 carbon steel, heat-treated chrome-alloy stainless steel, and work-hardened nickel stainless (302).

Three series of pins are available to meet varying load and service requirements. Light-duty pins are recommended for low shear loading. They are suitable for use in soft materials, such as aluminum, brass, plastic, and wood, and in delicate instruments.

Medium-duty pins are recommended for general fastening service where shear loads are of medium intensity, and shock and vibration loads are greater than the static shear loads.

Heavy-duty pins are recommended for extreme service conditions where shock and vibration loads are severe but are smaller than the static shear loads.

Other design options available include different materials and finishes, special sizes, and two additional series for extra-heavy and extra-light duty conditions.

Coil-spring characteristic of the spiral cross section will withstand high shock and vibration loads. Overlap on the outside surface is a slit edge and is slightly broken to prevent wear in moving parts. Orientation of the overlap in assembly with direction of applied load is not necessary.

These pins are suitable for application in blind or open locations. Assembly in production drilled holes is recommended. Pin ends are chamfered to

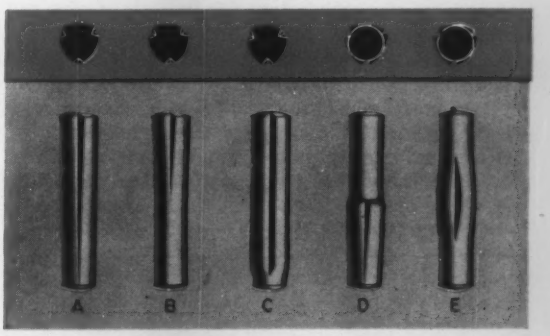


Fig. 7—Basic groove-pin constructions standardized by SAE. Representative applications of these pin types appear in Fig. 5 and 6.

Photo, courtesy Groov-Pin Corp.

Design of adjustable instantaneous trips in I.T.E. circuit breakers has been simplified through the use of light-duty spring pins. The pins fit into holes drilled in the shafts of the Bakelite adjustable trip buttons. In assembly, the spiral spring is slipped over the shaft of the button which is then inserted through the collar. Final step is to insert the spring pin through a hole in the shaft collar to hold the button in place. Spring action of the pin wall locks the pin in place but is not great enough to crack the plastic shaft.

Photo, courtesy Standard Pressed Steel Co.

facilitate assembly. In the selection of pin sizes for key applications in shafts, data given in Table 1 may be used as a guide.

Recommended hole tolerances are more liberal than those for other pin types. Plus tolerance values correspond to those given by the plot for spring pins in Fig. 8. In addition, minus tolerance values are permissible on nominal diameters of 1/16 in. and greater as follows:

Nominal Diam (in.)	Minus Tolerance (in.)
1/16 through 3/32	0.001
1/8 through 1/4	0.002
5/16	0.004
3/8	0.007
7/16	0.008
1/2	0.010

As in the case of groove pins, locking force developed by a spiral-wrapped pin is a function of length of engagement and pin diameter. Pin insertion and removal forces can be readily varied to meet specific application requirements through control of hole and pin size.

Light, medium, and heavy-duty pin constructions differ in thickness of metal-strip stock employed. For medium-duty pins made of heat-treated carbon steel, minimum double-shear strength varies from 300 lb for 1/16 in. size to 19,600 lb for ½-in. size. Comparable strength values for light-duty pins run about 50 per cent lower, those for heavy-duty types about 50 per cent greater. As a basis for comparison, shear strength of a heavy-duty pin slightly exceeds that for a solid, mild-carbon, cold-rolled steel pin of equivalent size.

SLOTTED TUBULAR PINS: Standard sizes of these pin fasteners provide a range of nominal diameters from 1/16 to ½ in. in lengths from ⅛ to 5½ in. Standard materials are heat-treated carbon steel, corrosion-resistant steel and beryllium copper. Other design options include different finishes, special pin lengths, and nonstandard wall thicknesses for light or heavy-duty service.

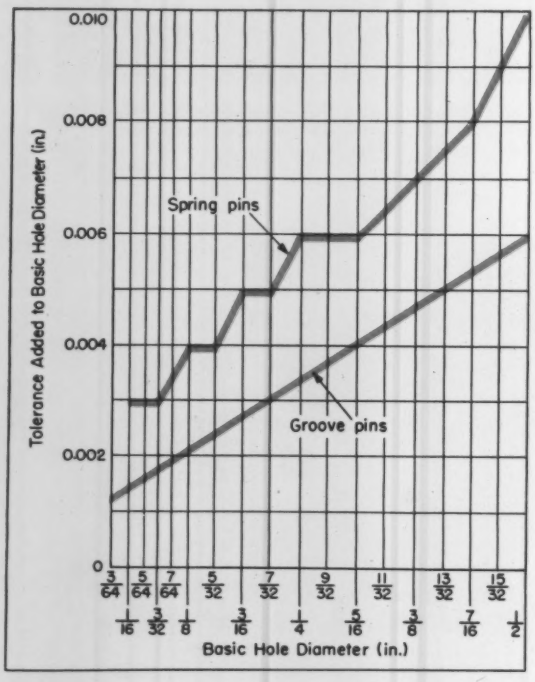


Fig. 8—Recommended hole tolerances for groove and slotted-tubular types of radial-locking pin fasteners.

Readily adaptable to manual or power-assembly techniques, these pins offer a tough yet resilient, self-locking fastener that can withstand high shock and vibration loads. Under normal application conditions, holes produced with standard fractional drills and held within the practical tolerances shown in Fig. 8 for spring pins will provide satisfactory locking action. Where critical factors or unusual materials are involved, some preanalysis of drill performance is advised. Punched or preformed holes that meet tolerance recommendations of Fig. 8 are also acceptable.

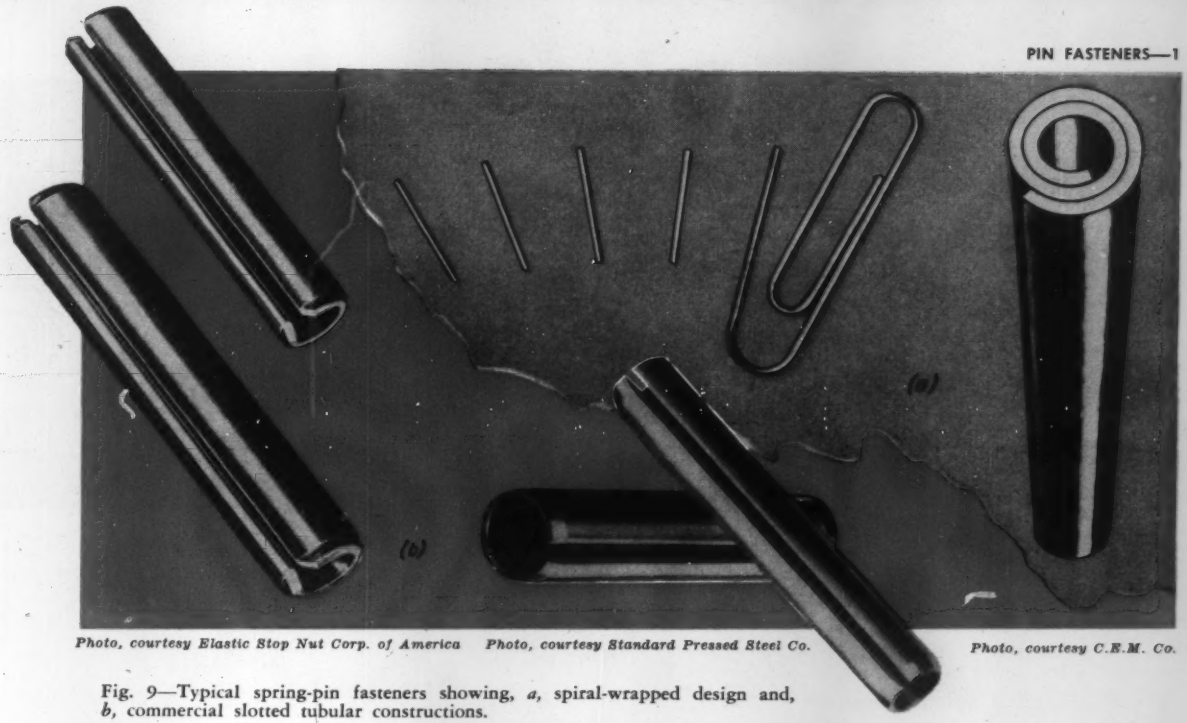
Recommended practices in the selection of slotted tubular pins for key applications in shafts are given in Table 1. For standard heat-treated carbon-steel pins, minimum double-shear strength (transverse) varies from 425 lb for the 1/16-in. size to 25,800 lb for the ½-in. size. These strength levels are slightly higher than provided by a solid mild-carbon, cold-rolled steel pin of equivalent size. When used as a longitudinal key, a slotted tubular pin in which the length is 2½ times the diameter develops a shear strength equal to the double transverse shear strength of the pin.

The foregoing shear-strength values are based on tests made with the pin slot positioned 90 deg from the direction of load application. In most cases where shear strength is not critical, random positioning of the slot will give satisfactory results. However, for maximum shear strength, the pin should be assembled so that the gap is in line with the direction of load and 180 deg away from the point of application. The maximum shear strength value provided by this gap orientation represents an increase of about 6 per cent over the minimum value.

Another practical method of increasing shear strength is to use pins in combination. Standard slotted tubular pins have been designed so that several sizes can be used inside one another. For example, a 3/32-in. size pin can be used in combination with one of 5/32 in. size. In such combinations, shear strengths of the individual pins are additive. Thus, the foregoing example, which combines individual strengths of 1000 and 3000 lb, provides a total double-shear strength of 4000 lb.

In double-pin assemblies, random orientation of slots is recommended. Also, when double pins are installed, it is recommended that the hole dimension be held to the high side of the tolerance to facilitate insertion. Advantages of the double pin construction include high resistance to impact loads and increased fatigue strength.

Assembly characteristics of slotted tubular pins parallel those of the other radial-locking pin types. Insertion and removal forces can be varied through control of hole and pin size. Normal elastic recovery of the pin material provides a continuing self-locking action when the pin is reinserted in



Photo, courtesy Elastic Stop Nut Corp. of America *Photo, courtesy Standard Pressed Steel Co.* *Photo, courtesy C.E.M. Co.*

Fig. 9—Typical spring-pin fasteners showing, *a*, spiral-wrapped design and, *b*, commercial slotted tubular constructions.

holes of approximately the same diameter. However, even though hole shape or size is not appreciably affected, holding action of the pin falls off somewhat after the first few reinsertions due to a burnishing action. In lighter metals and in aluminum or zinc diecastings, frequent reuse of slotted tubular pin fasteners may result in a minor broaching action which will also tend to decrease locking force.

As a guide to selection and application of slotted-tubular pin fastenors, certain rules of good design practice have been established and are presented in the following discussion. Most of them are equally valid for all types of pin fasteners.

Avoid conditions where the direction of vibration parallels the axis of the pin fastener. Although the slotted tubular pin can withstand the loosening effect of vibration in most applications, unusual conditions can result in an axial vibration component that bears careful evaluation. In such instances, accelerated vibration testing of prototype assemblies is advised.

Keep the shear plane of the pin a minimum distance of one diameter from the end of the pin.

In applications where engaged length is a minimum and appearance is not critical, allow pins to protrude the length of the chamfer at each end to develop maximum locking effect over the engaged length.

When deflection load on the pin is critical (closing of the gap), consider these possible solutions:

1. Increase pin diameter and length.

2. Increase shaft diameters in key applications. This will decrease the shear load on the pin and permit a higher torque to be transmitted with less deflection.

3. Reduce hole tolerance. The closer the hole is to minimum recommended size, the smaller will be the pin deflection.

4. Increase the length of the pin. Extending the length of the pin even beyond the edge of the hole into which it is inserted will lessen the amount of deflection.

5. Use a double-pin assembly or two pins of equal size in two different holes. Drilling two holes may be more economical than drilling and reaming one hole for a high-strength taper or dowel pin, and will considerably reduce deflection.

Quick-release pin fasteners will be discussed in the second and concluding article of this series to be published in a forthcoming issue.

ACKNOWLEDGEMENT

MACHINE DESIGN acknowledges with appreciation the co-operation of these companies in the presentation of this series of two articles:

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Driv-Lok Pin Co. (Driv-Lok groove pins) ..... Sycamore, Ill.
Elastic Stop Nut Corp. of America (Rollpin spring pin) ..... Union, N. J.
John Gillen Co. Inc. (Gillen groove pins, taper and dowel pins) ..... Cicero, Ill.
Groov-Pin Corp. (Groov-Pin) ..... Ridgefield, N. J.
Harley Patents Inc. (Harley quick-release pin) ..... New York
Hiller Helicopters ..... Palo Alto, Calif.
Lamson & Sessions Co. (cotter, clevis, and dowel pins) ..... Cleveland
D. W. Price Corp. (Ball-Lok quick-release pins) ..... Los Angeles, Calif.
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Waldick Engineering Co. (We-Pins) Garden City, N. Y.

Alloy Selection for BRAZING

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PRODUCTION volume need not necessarily be high to make brazing feasible. Many parts can be produced as brazed assemblies with little or no tooling. Certain parts, however, will require special tooling, the amount required depending upon the design of the part, Figs. 1 and 2.

Where it has been determined that tooling will be required for production of a given part as a brazed assembly, production volume becomes an important consideration. The quantity must be sufficient to make per-piece tooling cost acceptable when amortized over the anticipated total production.

Shape, size and weight are three factors that impose few if any limitations on the selection of the brazing process. In the case of weight, in fact, broad design flexibility is inherent in the brazing process. The wide variety of raw materials that lend themselves for use in a brazed assembly permits the design engineer to produce, for a given part, several designs which are identical in envelope, shape and function but which differ greatly in weight. Such flexibility allows selection of an assembly of optimum weight, an important factor in an installation where weight control is necessary for proper balance.

Just as a chain is only as strong as its weakest link, so the brazed-assembly strength is determined by the strength of its weakest component. Brazed-joint strength runs high and is determined in a given design by the components that make up the assembly. Conventional brazing methods will produce a joint having about 80 per cent of the strength of the base metal. Specialized brazing techniques have been developed and perfected by some companies wherein joint strength approaches 100 per cent of the base metal.

Another consideration is dimensional accuracy. Brazing may be considered feasible, using conventional techniques, when design requirements for a part fall within the range of generally accepted commercial tolerances. A design calling for greater dimensional accuracy may require special brazing equipment and techniques. Many brazed assemblies being produced today are meeting aircraft tolerances.

Some factors generally show up in brazed-design analysis as assets rather than limitations. One of the most important of these is appearance or eye appeal. A part will sometimes be placed inside a housing or covered with a shroud or panel because of poor appearance, even though the designer feels it should be exposed for easier assembly, greater maintenance accessibility or other reasons. Because tubular and stamped components are easily shaped and finished, a brazed assembly can be designed to meet the most stringent esthetic requirements without sacrificing functional properties. An example of appearance improvement plus cost savings is illustrated in Fig. 3. In an assembly where brazed tubing replaces threaded pipe, it is often possible to reduce the number of joints required. In such an assembly, brazing provides not only improvement in finished appearance, but a worthwhile revision of the design as well.

▶ Silver or Copper Brazing?

Production brazing may be accomplished either with silver or copper brazing alloys. Copper brazing is performed in a controlled-atmosphere furnace. For most jobs, the furnace will be a continuous, conveyorized unit. Lack of copper-brazing facilities in the designer's own plant should not rule out this process as a possibility. There are numerous highly qualified companies who specialize in this kind of work. These organizations not only have the equipment to perform copper brazing but have engineering staffs to assist in designing the brazed assembly.

Assembly Requirement	Preferred Brazing Alloy
Large size differential	Silver
Small size differential	Copper
Flatness	Silver
Appearance	Copper
High joint strength	Copper
Slip fit for assembly	Silver
Minimum fixturing	Copper
Low alloy cost	Copper
Retention of base-metal strength	Silver

Fig. 1—Copper-brazed transmission pan dip-stick guide assembly replaced die casting to reduce cost from $0.45 to $0.12. Due to close tolerance on angular relationship, a brazing fixture is used.

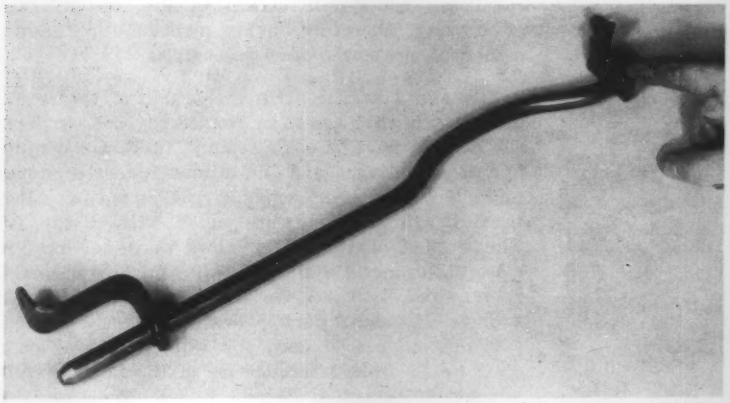
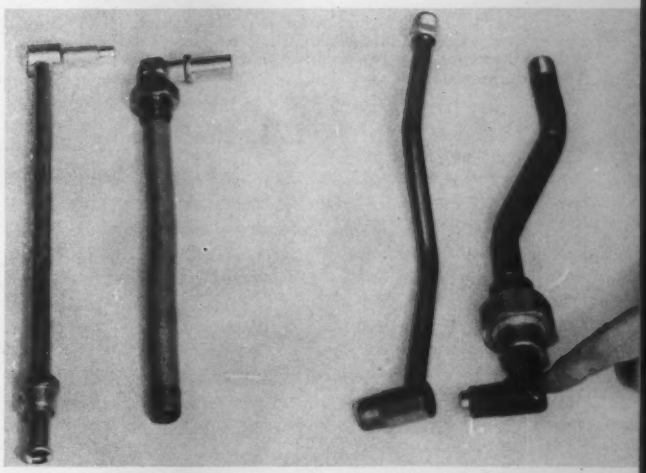


Fig. 2 — Left — Transmission selector rod has silver brazed joints between formed bar stock and two stampings. Joints meet torque specifications of 16,000 lb-in.

Fig. 3—Below—Hot-water heater-pipe assemblies were redesigned for copper brazing to improve appearance and reduce costs. Reductions realized were, left, $0.60 to $0.27; right, $0.65 to $0.31.



The choice between copper brazing and silver brazing for the production of a given part or subassembly should be made only after careful consideration of such factors as size and shape of part, cost of fixturing, assembly tolerance requirements, brazing-alloy cost and the number of secondary operations required following brazing.

Size and Shape: Size of assembly or of individual components is not a limitation with either silver or copper brazing. The factor influencing selection of one brazing process over the other is not the size of the assembly. If two components that are to be brazed together are of nearly equal size (no matter how large each may be), copper brazing, Fig. 4, is generally the best method. If one component is small in relation to the size of the component to which it is brazed, Fig. 5, silver brazing is generally favored. Rather than processing the whole part through the brazing furnace as is required in copper brazing, less expensive localized heating may be used for the silver-brazing process.

Another consideration influenced by size is the matter of flatness. Flat surfaces in large assemblies are generally difficult to hold within close dimensional limits where copper brazing is used. Silver brazing, using localized application of heat, will avoid the possibility of secondary operations where flatness is an important consideration.

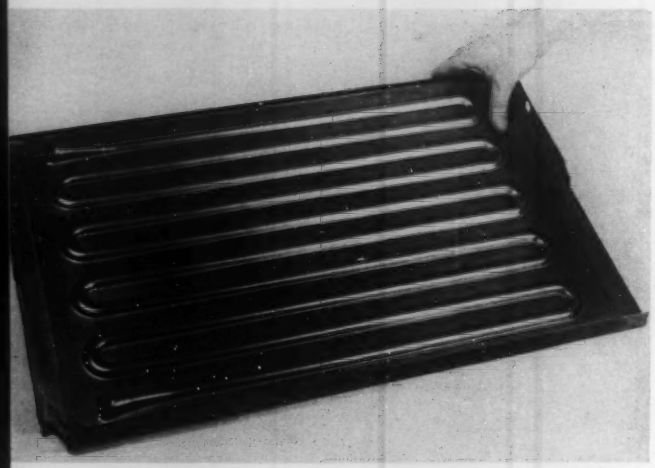


Fig. 4—Copper-brazed refrigerator plate carries freon. Assembly consists of two stampings brazed together; leakproof joints are essential.

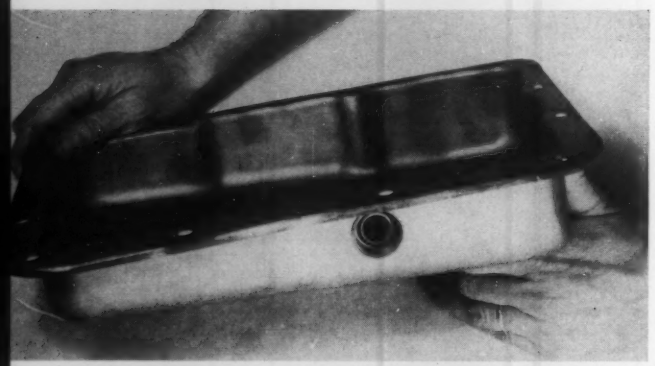


Fig. 5—Due to component size differential, silver alloy is used to braze threaded bushing to pan. Localized heat for silver-brazing also enabled assembly to meet flatness requirement.

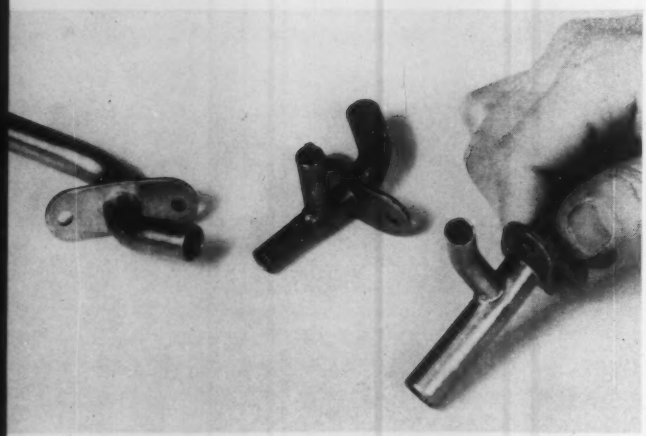


Fig. 6—Leakproof, copper-brazed vacuum-tube assemblies are for automotive power-brake unit. Silver brazing was not used due to costs and scale-free requirements.

Appearance: A more attractive assembly usually results when copper brazing is used. During silver brazing, a scale is formed which must be removed and the part cleaned following brazing. In addition, silver brazing requires that all components be thoroughly fluxed over the mating surfaces prior to brazing to prevent oxide formation which could result in an incomplete braze. Copper brazing, being a controlled-atmosphere furnace process, produces clean, scale-free parts ready for painting, plating or other surface-finish treatment. Fluxing prior to brazing is not required where copper is used.

Joint Strength: Another factor that may influence selection of the particular brazing alloy to use is joint strength. Strength of joints produced with either silver or copper is high; but copper alloy gives somewhat greater strength. With proper design and processing, both silver and copper brazing are capable of consistently producing absolutely leakproof joints. An assembly where brazed joints meet stringent specifications regarding leakage is shown in Fig. 6. The use of brazing, therefore, holds promise for the designer of pressure-vessel assemblies.

Fits and Tolerances: In the design of the actual components that are to be brazed together to form the desired part or subassembly, there are a number of advantages and limitations for both copper and silver brazing. Components designed for silver brazing are satisfactorily joined with a slip fit. The nature of the silver alloy does not require closer tolerances. Some sort of fixturing is usually required, however, to hold the components in proper alignment during brazing.

Where copper is used for the brazing alloy, a good press or interference fit in the mating components is required. Where two more-or-less flat surfaces are to be joined, the mating components must be spot or tack welded, or staked, to insure that both joint elements are in positive pressure contact. Because the press fit will usually put

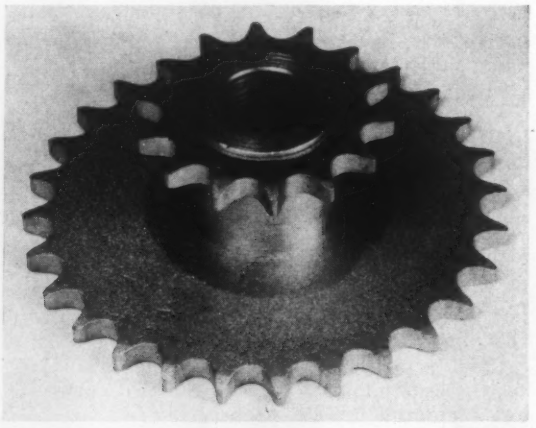


Fig. 7—Hub and sprocket assembly is copper brazed to meet 20,000 lb-in. static torque specification. Sprockets are press-fitted to shoulders on hub; brazing-alloy ring is placed in groove at hub end before assembly.

the components in proper alignment, brazing fixtures are seldom required where copper alloy is used.

Alloy Cost: Brazing-alloy cost, while often a very small part of overall assembly cost, is definitely a consideration. Copper brazing requires an interference fit, while a slip fit is satisfactory for silver brazing. This indicates that for a given joint, more silver alloy will be required than copper alloy. In addition, silver alloy in usable form for brazing is more expensive than the copper brazing alloy. This all adds up to the fact that in the matter of brazing-alloy costs, silver-alloy costs will be higher than copper-alloy costs.

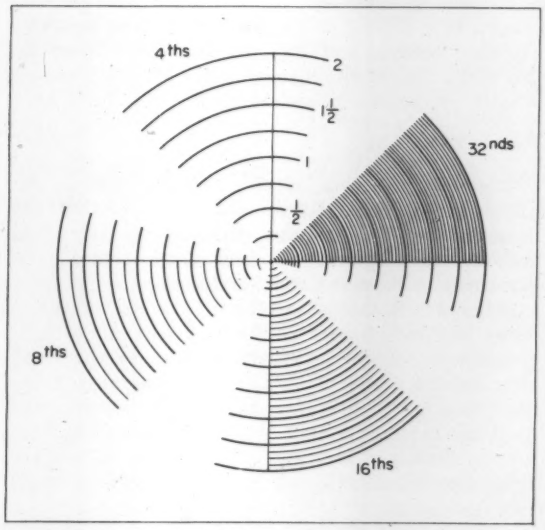
Base-Metal Strength: Where an assembly is copper brazed, exposure to brazing temperatures encountered in the controlled-atmosphere furnace has an annealing effect on the base metal and tends to cause a slight decrease in strength. This is usually of little consequence to the designer, but in some cases the loss in strength might be enough of a factor to discount the copper-brazing process. In such cases, silver brazing with only localized heating may be a satisfactory solution to the problem.

The selection criteria listed in the table will aid in selection of the proper brazing process. The final decision, as with almost every design decision, will be a compromise solution. Rare indeed is the part or subassembly where every criterion shows up as a plus factor in favor of silver or of copper. The pros and cons of silver brazing must be weighed against those of copper brazing and the decision made on the basis of this analysis. There may be times when they seem to stack up about equal. In such situations, it is generally advisable to select copper brazing due to lower cost, minimum tooling, and higher joint strength. When a brazing furnace is not available, production quantity will assist in determining relative advantages of having copper brazing done outside or keeping the work within the firm by using silver.

Tips and Techniques

Setting Compasses

As an aid for rapid setting of compasses, a template can be constructed. With the template, the required radius can be picked off directly, eliminating layout of the radius on the drawing. The template shown provides for all commonly used radii but can, of course, be adapted to suit individual requirements. Quick identification of the proper radius is facilitated by marking selected radii with heavy lines, in this case, each ¼ in. — J. E. GAMMIE and R. N. RUFFINI, *Penberthy Mfg. Co., Detroit, Mich.*



Retracing on Opaque Paper

To transfer a sketch from a translucent to an opaque paper, retrace the sketch on the back of the translucent sheet with a soft lead pencil. Place this side against the opaque paper and rub the face side with a piece of cotton wet with lighter fluid. Drawing over the transferred sketch on the opaque sheet will render a sharp reproduction, free of smudges.—TOM S. DEFAIL, *Westinghouse Electric Corp., Bettis Plant, Pittsburgh, Pa.*

Drawing Stylus

An empty ball-point pen cartridge can serve a useful purpose as a stylus. If the cartridge is inserted in a LeRoy lettering scriber, it may be used for lettering or drawing on stencils. The ball point permits pressing firmly without danger of damaging the stencil. — W. H. BURNETT, *chief draftsman, Hogan Laboratories Inc., New York.*

Rejuvenating Tracings

If many revisions on pencil tracings have left "ghosts" of erased lines, the tracing can be "rejuvenated" by rubbing the back of the tracing with cotton very lightly dampened with light machine oil (such as "3-in-1"). A trial attempt should be made on a small sample or obsolete drawing to determine the amount of oil to be used.—PETER DITORO, *New York, N. Y.*

Mechanics of Vehicles—11

Dynamics of Braking

By JAROSLAV J. TABOREK*
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Cleveland

BRAKING capacity, which determines the ability of a vehicle to slow down or stop, ranks as a major factor in the study of vehicle performance. This article—the first of two surveying the mechanics of decelerated motion—re-examines the principal motion-resisting and motion-aiding forces and evaluates their relationship to the braking problem.

Braking Forces: All possible forces that act on a decelerating vehicle on a downhill grade are shown in Fig. 62. As the primary motion-resisting force, braking force B originates in the frictional engagement between brake shoes and drums. The basic relationship is

$$B = \frac{F_b \mu_b r_b}{r} \qquad (185)$$

where F_b is the effective force on the shoe, μ_b is the coefficient of friction between shoe and drum, r_b is the drum radius, and r is the rolling radius of the tire. In calculations that follow, B is considered to be the sum of front and rear-axle braking forces, or $B = B_f + B_r$.

Ultimately, braking force B acts at the frictional connection between the tire and the ground. Governed by the same physical relationships that set vehicle tractive-force limits, maximum braking force B_{max} is given by the expression

$$B_{max} = W_b(\mu + f) \qquad (186)$$

For the rolling wheel, therefore, maximum transferable braking force is a function of the static road-adhesion coefficient μ, the rolling-resistance coefficient f, and the effective or dynamic axle weight W_b. Should the wheel lock during braking, skidding occurs, and B_{max} is then determined by the coefficient of sliding resistance μ_s. With locked wheels, maximum transferable braking force is

$$B_{max} = W_b \mu_s \qquad (187)$$

Complete analysis of the braking vehicle requires study of all forces and moments that are dependent on its state of motion. As shown in sections that follow, some of these factors are significant, others can be safely ignored.

DYNAMIC WEIGHT TRANSFER: The action of vehicle braking forces causes a dynamic weight transfer which increases the weight on the front axle and decreases it by the same amount on the rear axle. The effective axle weight, called the dynamic braking weight W_b, has a basic influence on the limits of braking performance and on the optimum distribution of braking forces to front and rear axles.

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- **decelerating forces**
- **engine-braking effects**
- **stopping time and distance**

GRADE EFFECT: For a vehicle braking on a grade, the significant vehicle weight is the normal-to-ground or cosine component. In braking calculations, the influence of the cosine factor is negligible, and the simplification $\cos \theta = 1$ is justified.

The sine component of vehicle weight (grade resistance R_g) is motion-supporting if the vehicle is moving downhill. In subsequent braking calculations, positive value for θ will be arbitrarily assumed as indicating a downhill slope.

ROLLING RESISTANCE: Always motion-opposing, total rolling resistance is independent of weight distribution on the axles. The basic relationship is

$$R_{rr} + R_{rf} = R_r = fW \cos \theta \approx Wf \qquad (188)$$

AIR RESISTANCE: Influence of air resistance R_a as a decelerating force is small at normal vehicle speeds, especially for streamlined vehicles. In braking calculations, therefore, the decelerative effect of air resistance is often neglected. In a sense, this simplification provides an additional safety factor in the calculations, since air resistance aids braking action when it is needed most, that is, at high vehicle speeds.

For very fast vehicles, special devices known as air-resistance brakes are sometimes used. The air brakes expand the projected area of the vehicle and simultaneously increase the air-resistance coefficient c_a.

INERTIA: The inertia force due to vehicle deceleration is given by an expression that first appeared in acceleration computations (Part 6):

$$R_i = bm \gamma_b \qquad (189)$$

In Equation 189, γ_b expresses the inertia effect of vehicle rotating parts. Its value is often different from that used in acceleration calculations because, in braking, the engine may be declutched, leaving only wheels and transmission parts to be decelerated. In such cases, γ_b for conventional automotive vehicles can be taken as about 1.04, that is, the translatory mass of the vehicle is increased 4 per cent to incorporate the rotating-mass effect of wheels and other permanently engaged rotating parts.

TRANSMISSION RESISTANCE: Transmission resistance torque M_t is the torque necessary to overcome friction of gears, bearings and joints plus torque due to churning of oil in the transmission. In the calculation of accelerated motion, these factors were taken care of by transmission-efficiency factor η, which expresses the loss of power between engine and drive axle. In braking, how-

Head Photo: Courtesy LeTourneau-Westinghouse.

ever, with the engine clutch disengaged, torque necessary to overcome transmission resistance is derived from the kinetic energy of the vehicle.

Compared to actual braking forces, magnitude of transmission resistance is small and can be neglected in braking performance calculations. However, where accurate results are required, transmission resistance may exert a significant effect.

ENGINE BRAKING POWER: Under certain circumstances, drag of a throttled engine is an important factor in the braking of vehicles. An engine running with closed throttle has a certain idling speed. To make the engine run faster with the throttle remaining closed, power must be supplied from an external source, for example, through consumption of part of the vehicle kinetic energy. In such cases, the engine acts as a brake. Engine braking power is proportional to engine speed and therefore to the reduction ratio used. For this reason, heavy vehicles on long downhill grades depend directly on the drag of the engine to aid braking, thereby reducing heat generated in the brake drums.

Torque M_{db} on the drive axle, derived from the engine braking effect, is given by

$$M_{db} = \frac{M_e \zeta}{\eta} \qquad (190)$$

Torque M_e required to drive the engine is measured experimentally at the engine output shaft, ζ is the total reduction ratio between engine and the drive axle, and η is the efficiency of the transmission. Since the efficiency term η appears in the denominator, lower efficiency means higher torque and therefore greater braking effect at the drive axle. A plot of braking torque M_{db} as a function of vehicle speed is represented for different gear reduction ratios in Fig. 63.

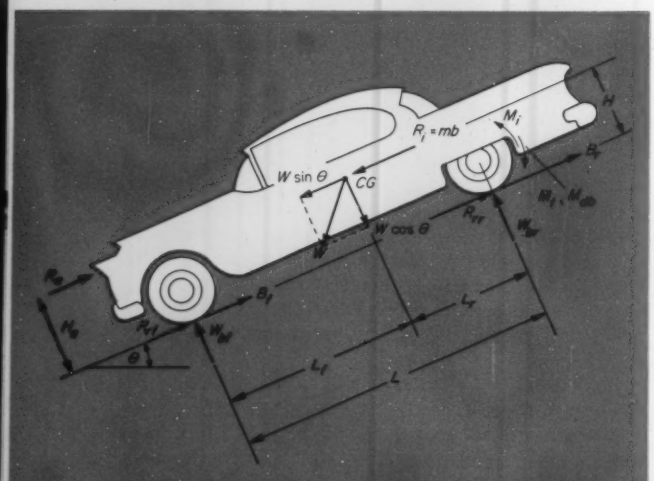


Fig. 62—Forces acting on a vehicle in decelerated motion downhill.

On heavy trucks it is sometimes necessary to increase the engine-braking effect by using the engine as compressor. This can be achieved by controlling valve timing, or by using restrictor valves in the exhaust system to increase the effective pressure in the cylinders.

Torque-Converter Transmissions: Braking potential of an engine can be utilized only in transmission trains that utilize a positive connection between engine and drive axle. Hydraulic transmissions and torque converters usually transfer power only from engine to drive axle, not from drive axle to engine. In such case, only the transmission resistance serves as a decelerating torque.

To permit use of hydraulic transmissions in heavy road vehicles, braking power of the engine can be replaced by other adjustable power-consuming devices, for example, by using flow restrictors in internal torque-converter circuits.

Optimum Engine Braking Performance: The foregoing discussion of braking by a driven engine applies strictly for low values of deceleration—for example, where a vehicle is being continuously braked downhill. To achieve high decelerations,

Nomenclature

B_f, B_r = Braking forces, represented as frictional forces at the tire-ground contact point, lb
b = Deceleration, ft per sec^2
c_a = Coefficient of air resistance
F_b = Effective force on brake shoe, lb
f = Coefficient of rolling resistance
g = Acceleration of gravity, ft per sec^2
M_{db} = Resistance moment of driven engine, lb-ft
M_i = Inertia moment of rotating parts, lb-ft
M_t = Resistance moment of transmission, lb-ft
m = Mass, lb-sec^2-ft^{-1}
R_a = Air resistance, lb
R_i = Inertia resistance of the translatory mass, lb
R_{rf}, R_{rr} = Rolling resistances, lb
r = Rolling radius of tire, ft
s = Braking distance, ft
t = Time, sec
V = Speed, mph
V_i, V_f = Initial and final speeds, mph
V_m = Mean vehicle speed, mph
v = Speed, fps
v_i, v_f = Initial and final speeds, fps
W = Vehicle weight, lb
W_b = Dynamic weight, lb
W_{bf}, W_{br} = Dynamic axle weights on front and rear axles, lb
W_{dr} = Weight of brake drum, lb
W_f, W_r = Static axle weights on front and rear axles, lb
W_{4f}, W_{4r} = Dynamic axle weights in four-wheel brake system, lb
W_b = Dynamic weight transfer in braking, lb
γ_b = Inertia mass factor of rotating parts in braking
ω = Angular speed, rad per sec
μ = Coefficient of road adhesion
η = Efficiency factor

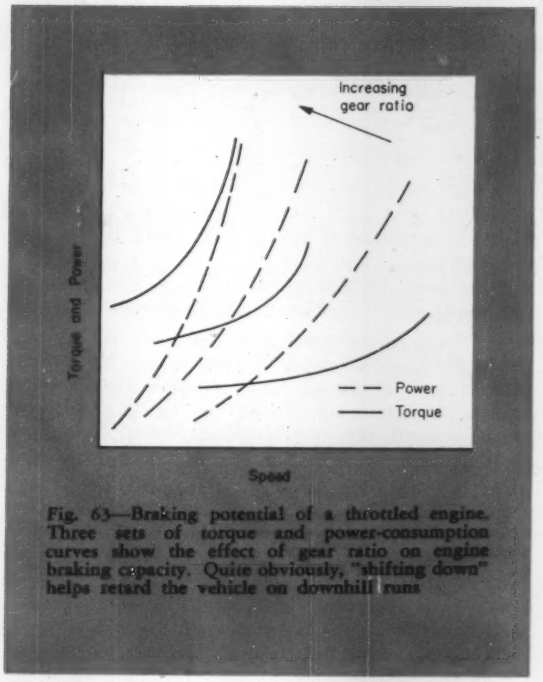


Fig. 63—Braking potential of a throttled engine. Three sets of torque and power-consumption curves show the effect of gear ratio on engine braking capacity. Quite obviously, "shifting down" helps retard the vehicle on downhill runs

brakes are applied very suddenly. In this case, the engine not only produces no braking effect but, to the contrary, consumes part of the mechanical braking effort to absorb kinetic energy of rotating engine parts.

Depending on the inertia of the engine as represented by factor γ, and consequently on reduction ratio ζ, a critical value of deceleration can be calculated above which the engine should be always disengaged for optimum braking effect.[43] For passenger cars the critical value is about 5 ft per sec.[2] As a general rule, therefore, it appears that the engine should be disengaged during most brake applications.

Dynamic Axle Weights During Braking: Forces acting on a vehicle during braking cause a weight shift toward the front axle. Knowledge of resulting dynamic axle weights is necessary for determination of maximum transferable frictional forces.

Dynamic axle reactions are best determined by writing moment-equilibrium equations around tire-ground contact points, thereby eliminating from the calculation all forces that act in the ground plane. Ground-plane forces are the braking force B, rolling resistance R_r, braking forces originating in engine and transmission, and the inertia torque M_i of rotating parts.

For a vehicle decelerating on a downgrade slope, Fig. 62, the equilibrium equations give the results:

$$W_{bf} = \frac{1}{L}\,(L_r\,W + HW\sin\theta + mbH - R_a\,H_a) \quad (191)$$

$$W_{br} = \frac{1}{L}\,(L_f\,W - HW\sin\theta - mbH + R_a\,H_a) \quad (192)$$

[43]References are tabulated at end of article.

To transform these equations into a more workable form, use is made of the following assumptions: 1. The action point of the air resistance is considered to fall at the cg of the vehicle, or $H = H_a$. 2. The simplified equilibrium-of-force expression is sufficiently accurate, where

$$mb - R_a + W\sin\theta = B + fW \quad (193)$$

Dynamic axle weights during braking then become

$$W_{bf} = \frac{L_r\,W}{L} + \frac{H(B + fW)}{L} \quad (194)$$

$$W_{br} = \frac{L_f\,W}{L} - \frac{H(B + fW)}{L} \quad (195)$$

Designating dynamic weight transfer during braking as ΔW_b,

$$\Delta W_b = \frac{H(B + fW)}{L} \quad (196)$$

Dynamic axle weights can then be written as

$$W_{bf} = W_f + \Delta W_b \quad (197)$$

$$W_{br} = W_r - \Delta W_b \quad (198)$$

where W_f and W_r are static level axle weights.

Equations of Decelerated Motion: Equations of decelerated motion for a vehicle are derived in a manner similar to that used for accelerated motion. According to the energy theorem, change in kinetic energy of a moving body equals work produced by external forces. Applying this principle to a vehicle in decelerated motion, change of kinetic energy in differential distance ds is

$$dE = \left(B + \sum R\right) ds \quad (199)$$

where the effective retarding force is obtained through summation of the actual braking force B and all external resistance forces acting on the vehicle at that instant. Kinetic energy of translatory and rotating parts is given by

$$E = \frac{mv^2}{2} + \sum \frac{I\omega^2}{2}$$

Differentiated, the expression becomes

$$dE = mv\,dv + \sum I\omega\,d\omega \quad (200)$$

By use of the technique developed in Part 6 of this series, the effect of rotating parts is represented by an equivalent translatory mass. Equation 200 then becomes

$$dE = vdv\left(m + \frac{1}{r^2}\sum I\zeta^2\right) = vm\,\gamma_b\,dv \quad (201)$$

where γ_b is the factor expressing the inertia effect of wheels and other rotating parts.

When Equation 201 is substituted in Equation 199 and with $b = dv/dt$, the general equation

of decelerated motion becomes

$$B = bm\,\gamma_b - \sum R \qquad (202)$$

From the foregoing equation, the state of motion of a vehicle and the forces involved in the braking process can be readily calculated.

Stopping Distance: For calculation of stopping distances, Equations 199 and 201 are equated, or

$$ds\left(B + \sum R\right) = vm\,\gamma_b\,dv \qquad (203)$$

In integral form, Equation 203 becomes

$$s = \gamma_b\,m \int_{v_f}^{v_i} \frac{v\,dv}{B + \Sigma R} \qquad (204)$$

Here, v_i is initial speed, and v_f is final speed. In the integration of Equation 204, either of two assumptions can be made: 1. Air resistance is negligible. 2. Air resistance is significant. The following sections show the effects of these assumptions.

AIR RESISTANCE NEGLECTED: When air resistance is neglected, deceleration is constant during braking, and the solution of Equation 204 is

$$s = \frac{\gamma_b\,m}{B + \Sigma R}\left[\frac{v_i^2 - v_f^2}{2}\right] \qquad (205)$$

Therefore, minimum full-stop braking distance with four-wheel brakes ($B_{max} = W\mu$) is

$$s_{min} = \frac{v_i^2\,\gamma_b}{2g(\mu + f)} = \frac{V_i^2\,\gamma_b}{64(\mu + f)}\left[\frac{5280}{3600}\right]^2$$

$$= \frac{\gamma_b\,V_i^2}{30(\mu + f)} \qquad (206)$$

where dimensions of s are in ft, v in ft per sec, and V in mph.

It is seen, therefore, that if air resistance is neglected, stopping distance is independent of vehicle weight.

AIR RESISTANCE CONSIDERED: Since air resistance is a function of speed, vehicle deceleration changes continuously during the braking process. Before substitution in Equation 203, the familiar air-resistance equation can be rearranged to read

$$R_a = 0.0012\,c_a\,Av^2 = Cv^2$$

where v is instantaneous speed in ft per sec. Solving for C,

$$C = \frac{c_a\,A}{840} \qquad (207)$$

On level ground only air and rolling resistances act on the vehicle, and the stopping-distance equation becomes

Example 4—Braking Distance and Time

Problem: Determine minimum stopping distance on dry concrete ($\mu = 0.6$, $f = 0.02$) from initial speed $V_i = 100$ mph. The vehicle weighs 4000 lb, has projected frontal area $A = 25$ sq ft and air resistance coefficient $c_a = 0.5$. The engine is disengaged during deceleration, and the inertia factor for wheels and transmission parts is $\gamma_b = 1.05$.

NEGLECTING AIR RESISTANCE: From Equation 206, minimum stopping distance with air resistance neglected is

$$s_{min} = \frac{1.05(100^2)}{30(0.6 + 0.02)} = 570 \text{ ft}$$

INCLUDING AIR RESISTANCE: From Equation 211, minimum stopping distance including the effect of air resistance is

$$s_{min} = \frac{13.1(1.05)(4000)}{0.5(25)}\log_e\left[1 + \frac{0.5(25)(100^2)}{390(4000)(0.6 + 0.02)}\right]$$

$$= 4400 \log_e 1.129 = 532 \text{ ft}$$

Stopping distances with and without the air-resistance effect are of approximately the same magnitude, differing by about 7 per cent. This difference, of course, is greater at higher initial speeds.

Coasting: For a free-rolling vehicle acted on only by rolling and air resistance, $B = 0$ and Equation 210 gives the coasting-distance as

$$s = \frac{13.1\,\gamma_b\,W}{c_a\,A}\log_e\left[1 + \frac{c_a\,A\,V_f^2}{390(Wf)}\right]$$

Substituting numerical values,

$$s = \frac{13.1(1.05)(4000)}{0.5(25)}\log_e\left[1 + \frac{0.5(25)(100^2)}{390(4000)(0.02)}\right]$$

$$= 4400 \log_e 6.0 = 7100 \text{ ft}$$

Stopping time for the free-rolling vehicle ($B = 0$) is given by Equation 215 as

$$t = \frac{0.9\,\gamma_b\sqrt{W}}{\sqrt{f\,c_a\,A}}\tan^{-1}\frac{V_i}{19.7}\sqrt{\frac{c_a\,A}{Wf}}$$

Substituting numerical values,

$$t = \frac{0.9(1.05)\sqrt{4000}}{\sqrt{0.02(12.5)}}\tan^{-1}\frac{100}{19.7}\sqrt{\frac{12.5}{4000(0.02)}}$$

$$= 120 \tan^{-1} 5.1\sqrt{0.156} = 133 \text{ sec}$$

Average deceleration b is therefore

$$b = \frac{1.47(100)}{133} = 1.11 \text{ ft per sec}^2$$

$$s = \gamma_b\, m \int_{v_f}^{v_i} \frac{v\, dv}{B + R_r + Cv^2} \qquad (208)$$

Letting $z = v^2/2$ and $dz = v(dv)$, integration gives

$$s = \frac{\gamma_b\, m}{2C} \log_e \left[\frac{B + R_r + Cv_i^2}{B + R_r + Cv_f^2} \right] \qquad (209)$$

Braking to a full stop ($v_f = 0$) from initial speed V (mph),

$$s = \frac{\gamma_b\, m}{2C} \log_e \left[1 + \frac{C\, V_i^2}{B + R_r} \left(\frac{5280}{3600} \right)^2 \right] \qquad (210$$

With the substitution of C from Equation 207 and $B_{max} = W\mu$ for maximum braking force, the minimum-stopping distance expression becomes

$$s_{min} = \frac{13.1\, W\, \gamma_b}{c_a\, A} \log_e \left[1 + \frac{c_a\, A\, V_i^2}{390\, W(\mu + f)} \right] \qquad (211)$$

Stopping distance where air resistance serves as a braking aid is therefore a function of vehicle weight. This is because the same air-resistance force acts on vehicles of the same aerodynamic form regardless of weight. Therefore the effect of air resistance on a lighter vehicle is more pronounced.

Stopping Time: Time required to reduce speed of a vehicle from v_i to v_f is calculated from Equation 203. With the substitution $v = ds/dt$, Equation 203 can be rearranged to give

$$t = \gamma_b\, m \int_{v_f}^{v_i} \frac{dv}{B + R_r + Cv^2} \qquad (212)$$

After integration,

$$t = \frac{\gamma_b\, m}{\sqrt{C(B + R_r)}} \tan^{-1} \sqrt{\frac{C}{B + R_r}}\, (v_i - v_f) \qquad (213)$$

After substitution of C from Equation 207, braking time to a full stop ($v_f = 0$) is given as

$$t = \frac{\gamma_b\, W}{g} \sqrt{\frac{840}{(B + R_r)c_a\, A}} \times \tan^{-1} 1.47\, V_i \sqrt{\frac{c_a\, A}{840(B + R_r)}} \qquad (214)$$

Minimum stopping time ($B_{max} = W\mu$) is

$$t_{min} = 0.9\, \gamma_b \sqrt{\frac{W}{(\mu + f)c_a\, A}} \tan^{-1} \frac{V_i}{19.7} \sqrt{\frac{c_a\, A}{W(\mu + f)}} \qquad (215)$$

When air resistance is neglected, the kinematic equation for decelerated motion applies, and

$$t = \frac{v_i}{b} = \frac{1.47\, V_i}{b} \qquad (216)$$

Representative calculations for stopping distance and time are given in Example 4.

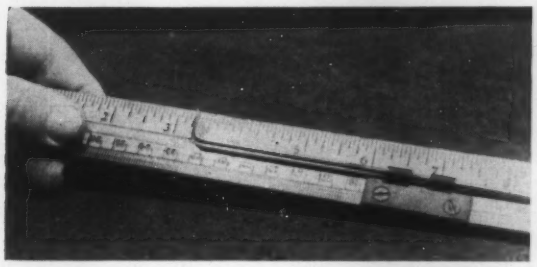
In the next part of this series, braking-performance limits as established by maximum transferable friction and by thermal considerations are examined.

REFERENCES

43. A Jante—"Muss man beim Bremsen auskuppeln" (When to Disengage the Engine in Braking), Automobiltechnische Zeitschrift (ATZ), 1942.

Tips and Techniques

Measurement-Holding Clip



It is a simple matter to make a ruler attachment which will hold any measurement. Half of a small brass hinge is needed, and a short length of rod or stiff wire the size of the hinge hole. One end of the wire is bent at right angles and pointed to provide the indicator, as shown. One side of the hinge is fastened to the center of a ruler with wood screws or thumb tacks. The hinge eyes are bent slightly out of alignment so that the indicator rod will not slide too freely.

In use, the indicator rod is moved to a position to indicate any given dimension. It will then hold this measurement to permit transfer of the exact measurement to another location. There is no need to mark the ruler with pencil lines to indicate fractional measurement to be remembered. If the rod is long enough, the ruler may be used as a make-shift caliper or depth gage.—GLEN F. STILLWELL, *Manhattan Beach, Calif.*

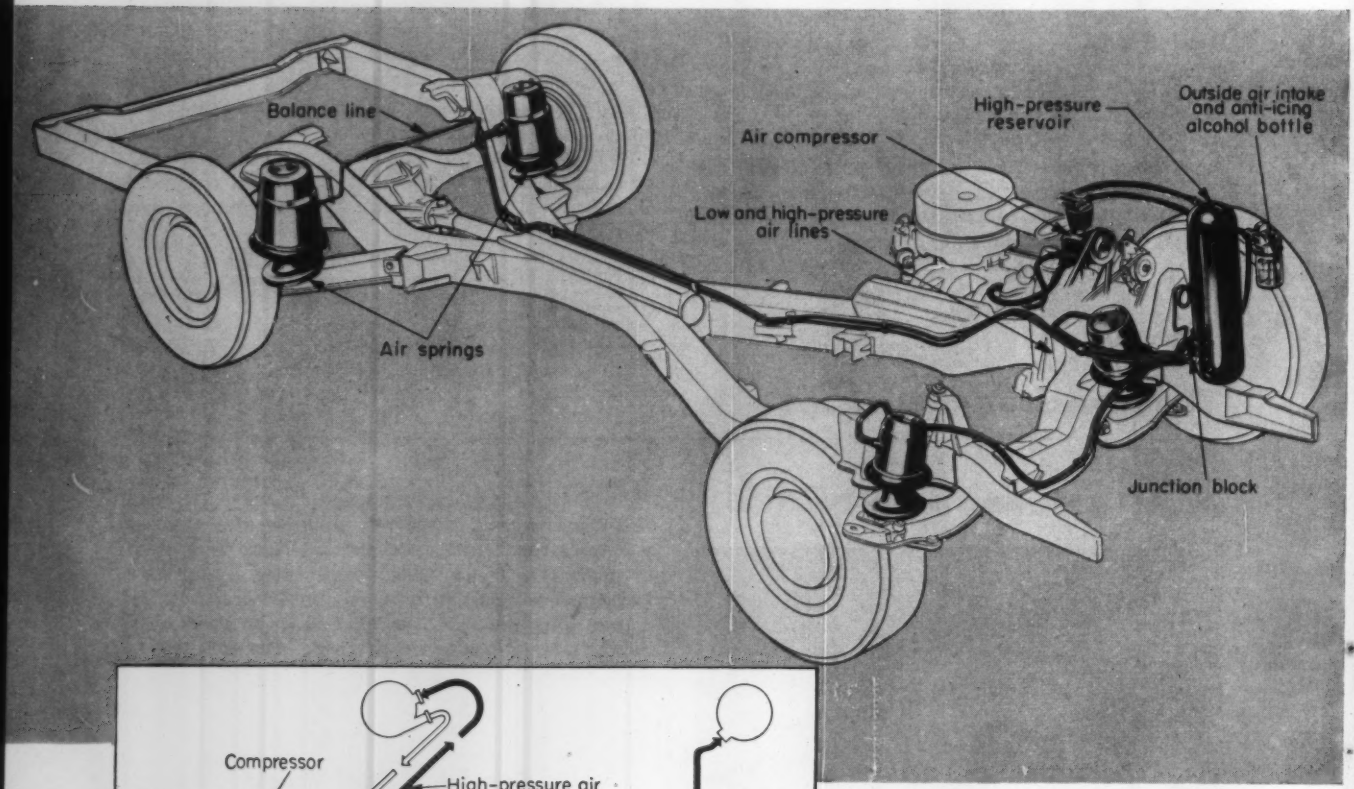
Calculating Steel Weight

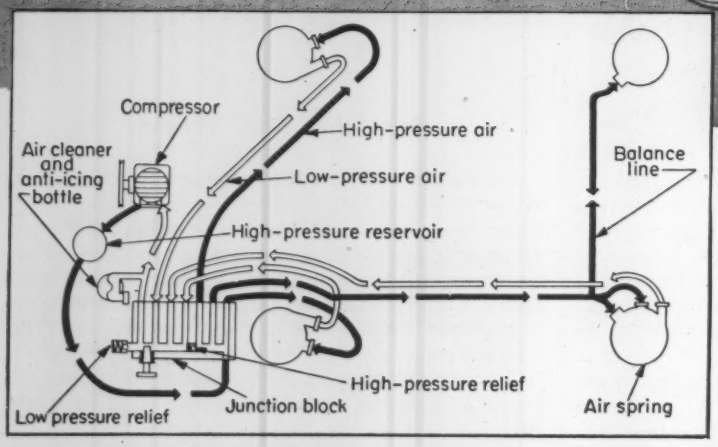
The weight of steel can be accurately calculated by remembering two simple formulas. For flats, rectangles, plates, and squares: multiply width by thickness, multiply by ten, and divide by three. For rounds, multiply the diameter by four, square this figure, and divide by six. Both give the result in pounds per foot. For rectangular shapes, this formula gives a weight that is two-per cent light; for rounds, the formula gives handbook accuracy.—THOMAS C. ROSTRON, *Schramm Inc., West Chester, Pa.*

Air-Leveling System

SUSPENSION SYSTEM COMPONENTS include an air cleaner with an alcohol receptacle to prevent icing in cold weather, a compressor, a high-pressure accumulator, air-line junction block, a bellows and reservoir at each wheel, leveling valves, and air lines.

A metered amount of air is taken from the atmosphere through the alcohol to the compressor and stored in the accumulator. A high-pressure line leads from the accumulator to the junction block which serves as a manifold for feeder and exhaust lines. Air lines from the block form a continuous circuit through the bell-shaped air-spring housing, where valving controls interior pressures. Air is forced into the system only when the exhaust chamber of the junction block lacks sufficient pressure.

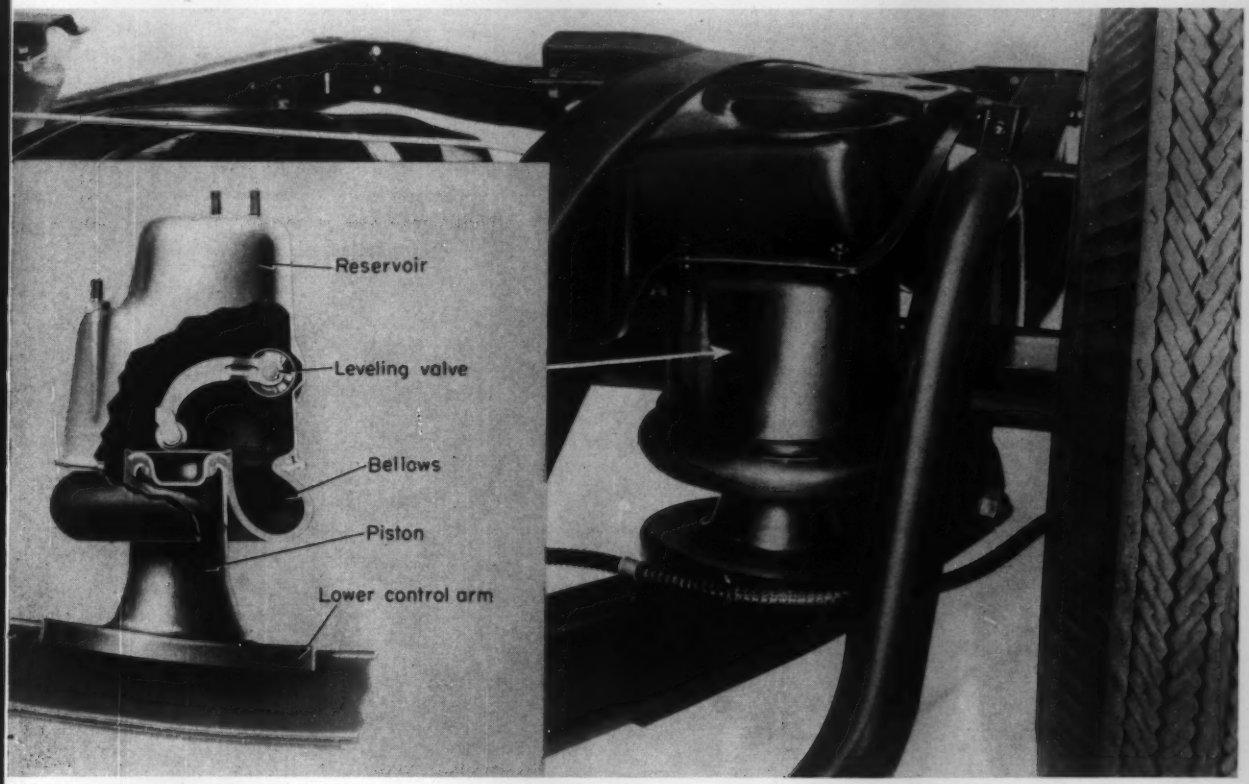




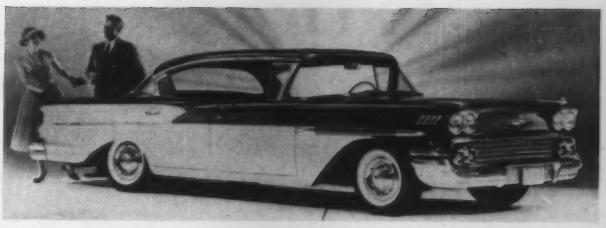
Adjusts Vehicle Height

AIR-SPRING ASSEMBLY consists of a stamped-steel reservoir mounted to the chassis frame with one end closed over by a fabric-reinforced rubber bellows. A piston fixed to the suspension lower control arm applies vehicle weight to the center of the bellows.

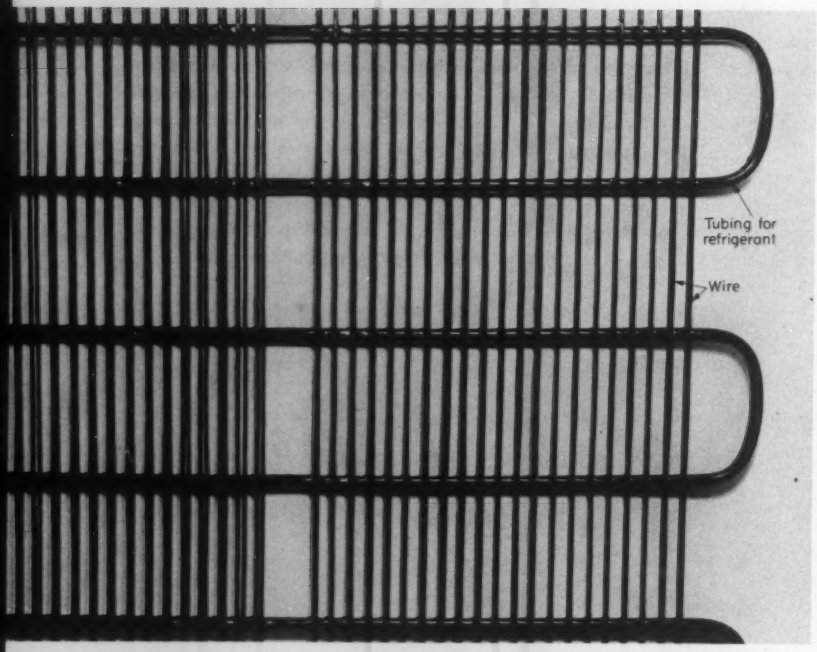
In each air-spring bellows unit is a two-way leveling valve opened and closed by an arm-and-roller unit that follows piston movements. When passengers enter the car, their weight forces the frame and integral air reservoir downward; the valve control arm moves up and the intake valve opens; air is forced into the reservoir and the increased pressure raises the frame to design distance from the axle. When load is removed, the frame and reservoir rise; the control arm opens the exhaust valve; air leaves the reservoir and the frame again returns to design height. By design, rapid movements of the control arms due to road irregularities produce no significant effect on system pressure.



AN ALL-PNEUMATIC suspension system is offered as optional equipment on 1958 Chevrolets. Entire weight of the body and frame is supported on a cushion of air. In addition, the Level Air suspension system also automatically keeps height the same regardless of changes in loading conditions.



Home Refrigerator Is



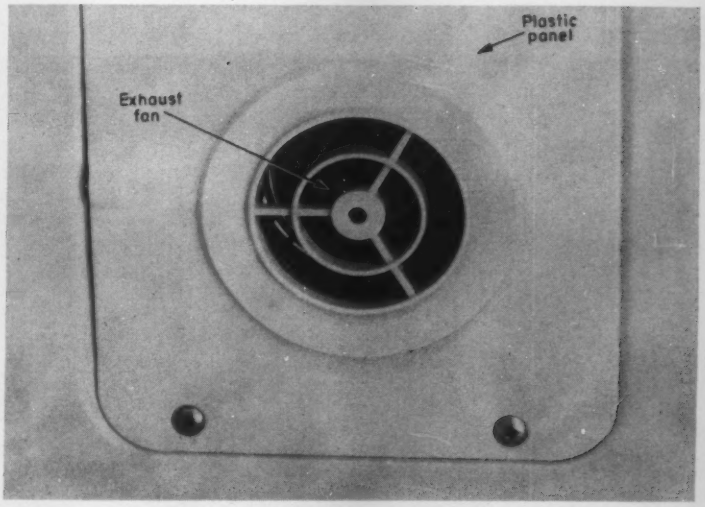
REFRIGERATED PLATE is made up of wire and tubing instead of the customary metal sheet and tubing. Advantages claimed for this new design are a more efficient exchange of heat, better air circulation, greater flexibility of manufacture, a 60 per cent reduction in labor costs, and a 15 per cent decrease in material costs.

Westinghouse uses 0.062-in. diameter wire and 3/16-in. diameter tubing in the condenser. The tubing is continuous in length and is mounted in a sinuous or serpentine form. Spacing between the 180-deg turns is 2 in. on center while length of swing varies from 22 in. minimum to 25 in. maximum. Wires are spaced on centers 1/4-in. across the refrigerated plate and through the food compartment.

A HIGH-SPEED COOLING SYSTEM is featured in the design of the 1958 Westinghouse refrigerator line. As reported by Robert Dobbie and Philip Facey, product design engineers from the Westinghouse Electric Appliance Div., a forced-air circulating system is used. It is claimed that the system permits control of inside temperature to within 1 F.

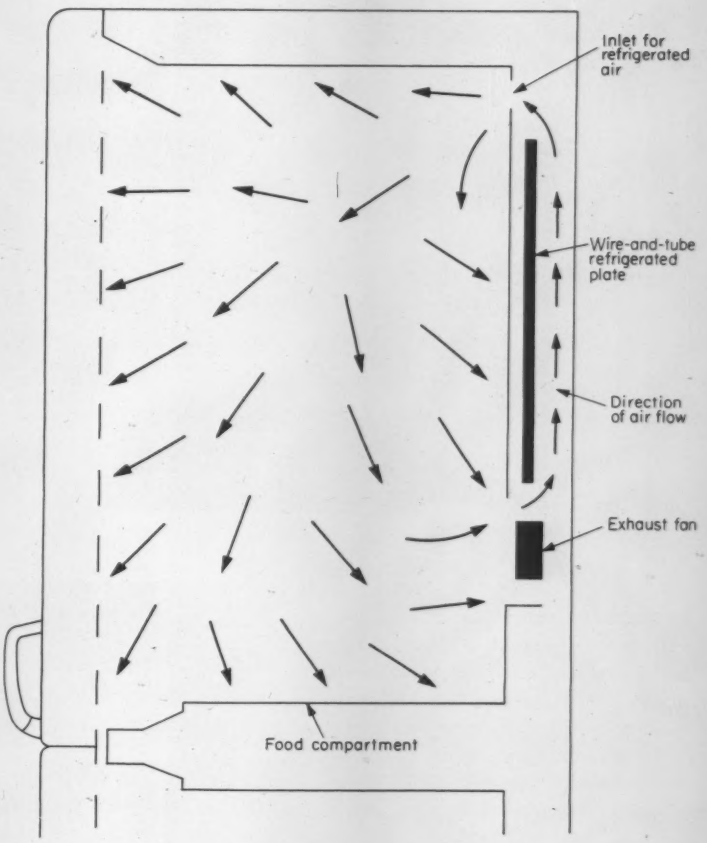
Forced-Air Cooled

AIR CIRCULATION is controlled by a blower-type exhaust fan. It has a 20 cfm capacity which permits changing air in a 10-ft box two times a minute. With conventional air circulation, dependent on convection currents, a complete air change requires 5 to 10 minutes. The fan is mounted on a plastic panel in the back of refrigerator.

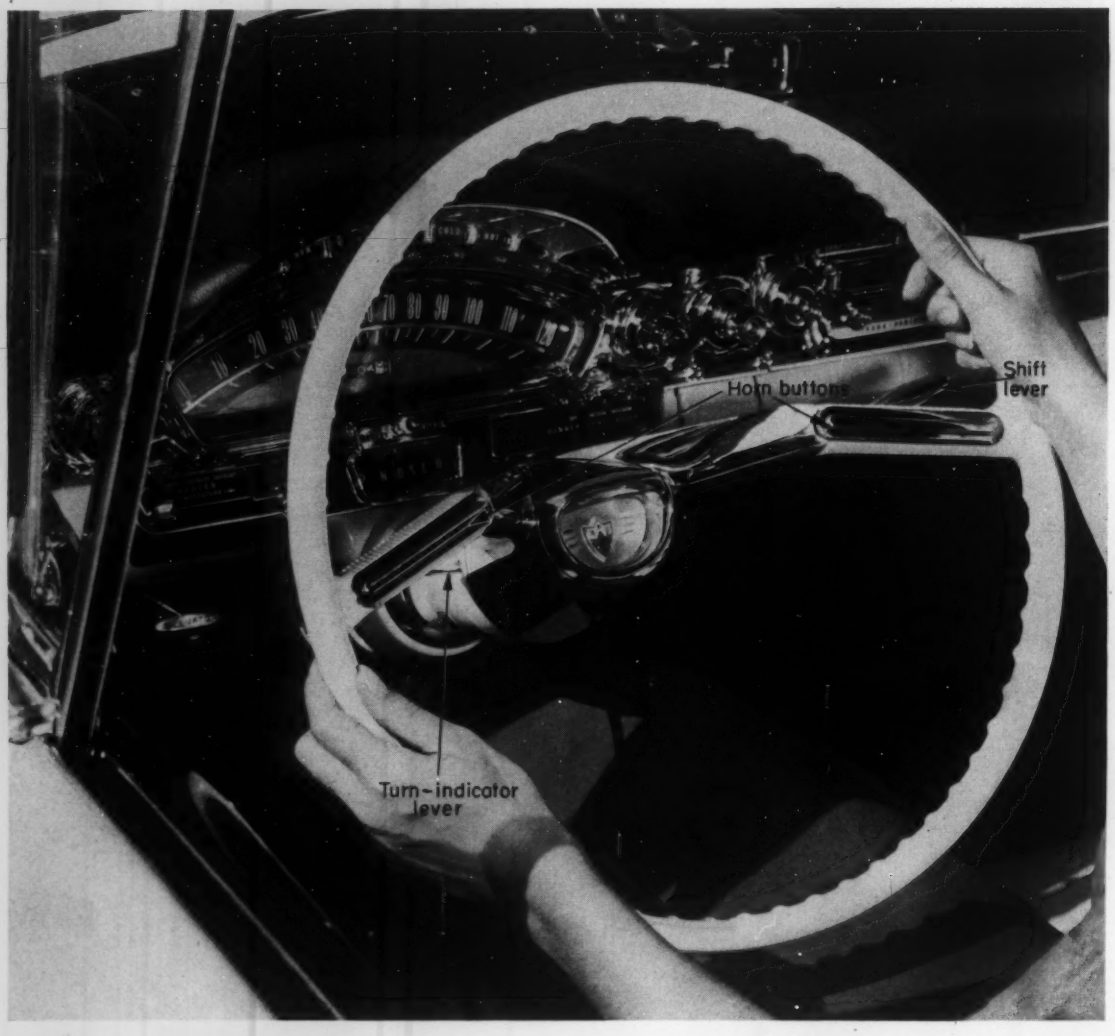


DURING THE COOLING CYCLE when the compressor and air circulating fan are both running, the air stream carries heat from the food storage compartment over the refrigerated plate located between the rear inner and outer walls. When the cold-plate temperature reaches 0 F, the compressor is turned off but the fan continues to run. Warm air from the food storage compartment soon raises the temperature of the cold plate to 36 F. At this point, the compressor is again turned on, and the cooling cycle repeated.

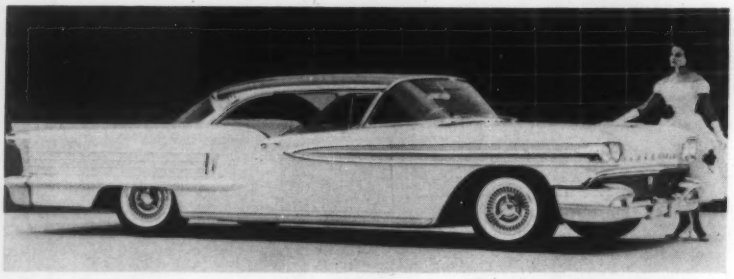
It is during the time when the compressor is off that the refrigerator is defrosted automatically. When the temperature of the cold plate reaches 32 F, any ice formed on it melts and runs off as water. This defrost water is collected in a pan at the bottom of the refrigerator. It is evaporated during the cooling cycle by the heat energy removed from the food storage compartment.



Horn Buttons Designed into Steering-Wheel Spokes

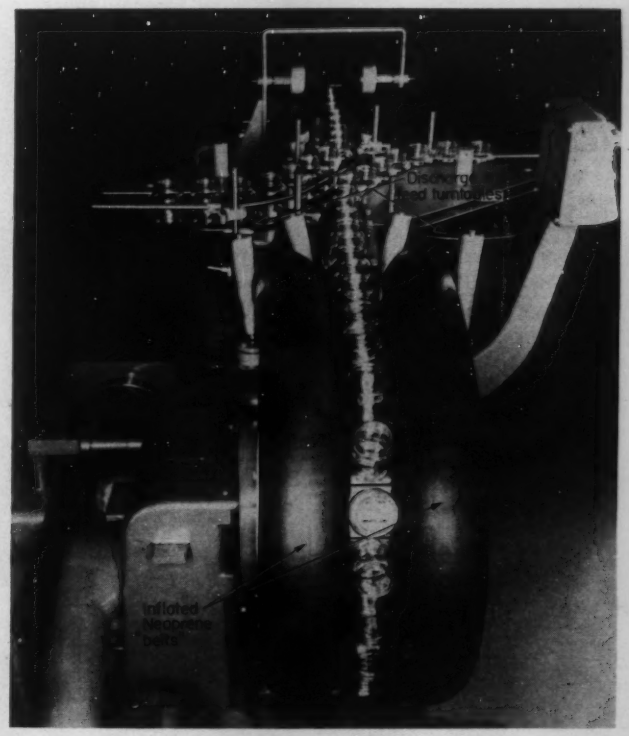


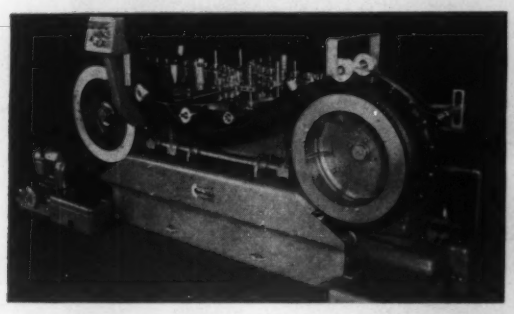
IN THE 1958 OLDSMOBILE, rectangularly shaped horn buttons are built into the upper section of the steering-wheel spokes. It is claimed that this feature, coupled with the close-proximity of the automatic transmission shift lever and the turn indicator lever, permits the driver to keep a firm grip on wheel at all times.



Inflated Neoprene "Belts" Invert Glass Jars at High Speed

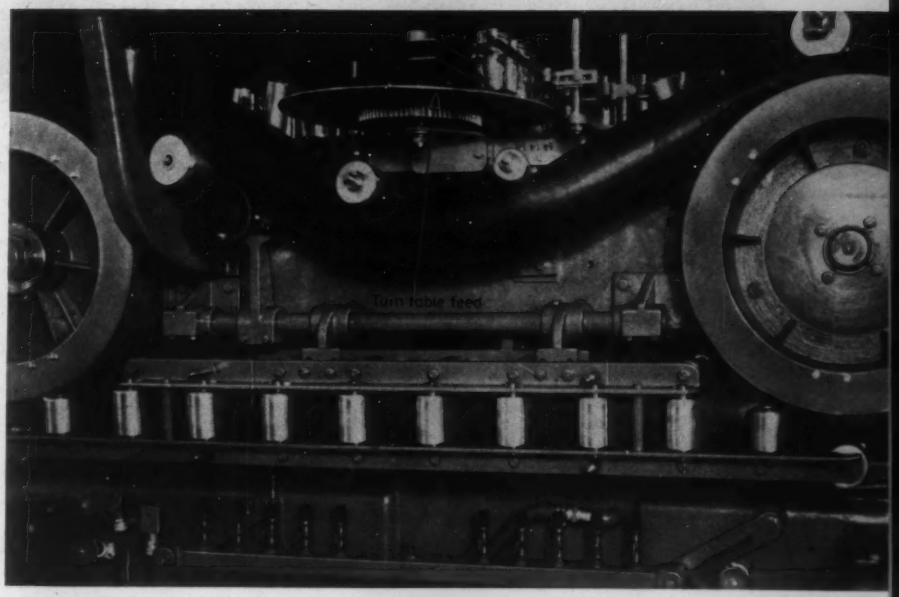
HIGH-SPEED HANDLING of glassware and other fragile containers, with practically no noise, is accomplished in new machine made by the Pneumatic Scale Corp. Ltd., Quincy, Mass. A pair of neoprene tubes inflated to 2 psi picks up containers in an upright position and inverts them in rapid succession. The pneumatic tubes move the inverted jars to a location in the machine where two series of five air jets each blow out dust and dirt. Cleaned containers are returned to an upright position and are discharged at speeds to 500 per minute.





ROTARY TURNTABLES move containers into the path of the inflated-tube pair and discharge them from the cleaner.

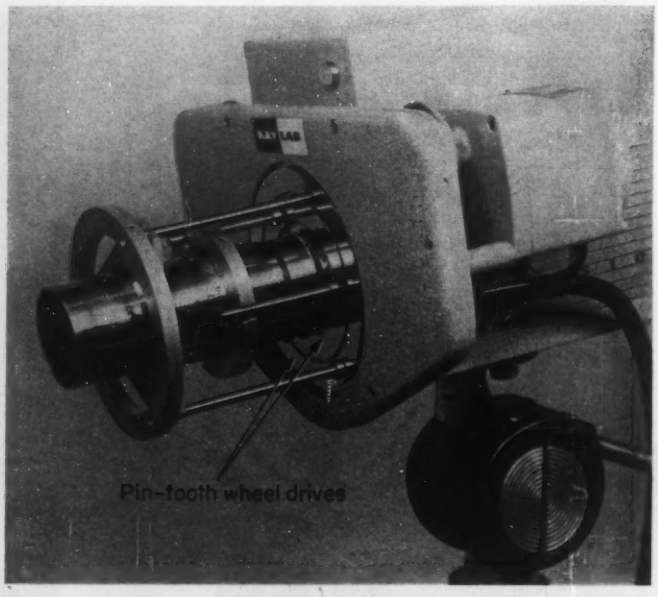
The machine has only two basic adjustments. One is a wheel to raise or lower position of blowing jets to suit container height. The other adjustment is a wheel which controls the amount of grip exerted by the pneumatic tubes to take care of different container sizes the equipment may handle.

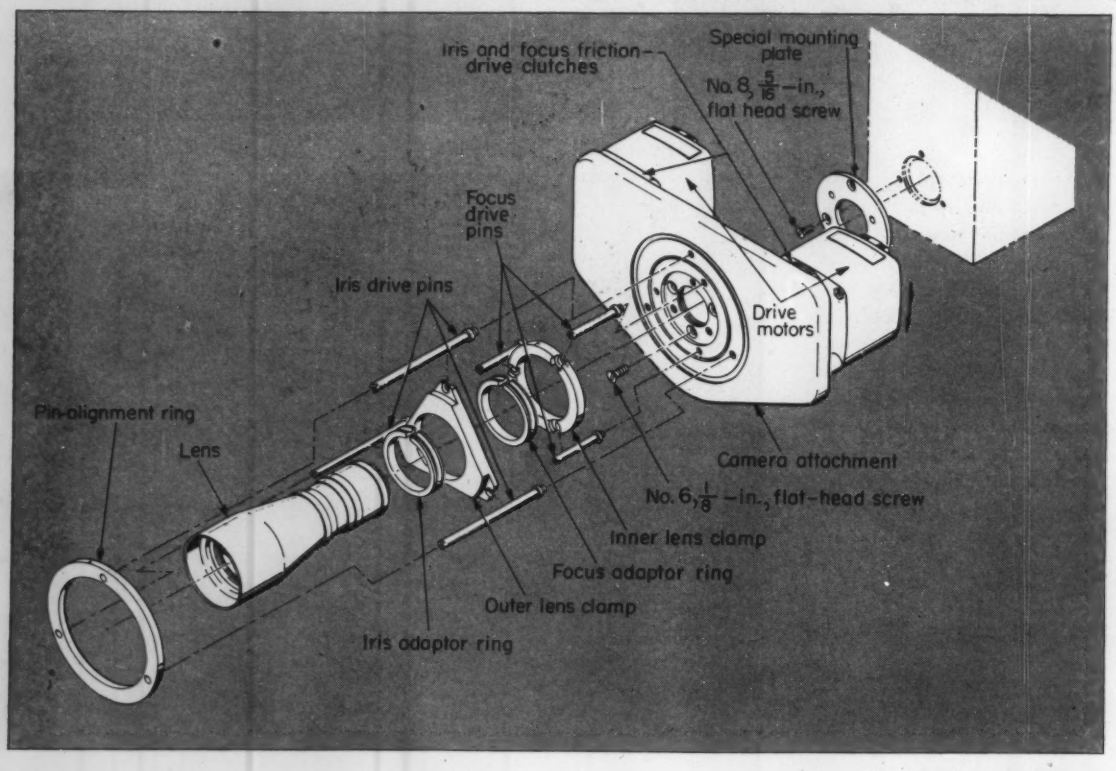


Concentric Pin-Tooth Wheels Adjust TV Camera Lens

REMOTELY CONTROLLED IRIS-FOCUS ADJUSTMENT unit for Kin Tel industrial TV cameras employs a novel drive system. Two 8-w motors are used to drive two friction clutches which in turn drive two concentric rings. Each ring is independently rotated. Mounted in each ring are three long pins. One of these concentric pin-tooth wheels engages with an inner lens clamp and other with an outer lens clamp. Rotating one clamp changes the focus whereas the other one adjusts the iris opening.

The advantage of this drive and coupling technique is that no permanent attachments are made to the camera lens. The two clamps are secured to the lens with Allen screws.





Detecting Resonant Frequencies in Complex Structures

By **RUSSELL F. THIELMAN**
Project Engineer
Jack & Heintz Inc.
Cleveland, Ohio

A new method of measuring mechanical resonance in members of a complex structure by means of phase angles, accomplishes what presently-used basic methods cannot—detection of members causing excessive response and those being driven by the resonant member

IN MANY applications, complex structures are exposed to vibration frequencies which induce resonance in one or more members of the structure. Therefore, it is desirable to evaluate accurately the critical frequency of each member so that fatigue life of the structure at resonance may be determined.

In some cases, such as equipment driven by electric motors, vibration occurs essentially at a single frequency. In other cases, such as aircraft, the structure is exposed to a wide range of forcing frequencies. The method outlined here can be used in either situation.

When a dynamic response curve showing more than one peak is obtained from a structure ex-

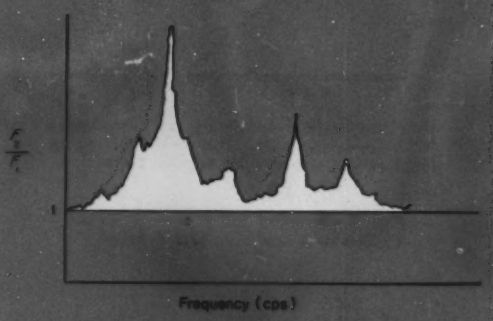


Fig. 1 — Above — Response of a typical structure to forced vibration. Structure experiences maximum dynamic stress when ratio F_2/F_1 is maximum.

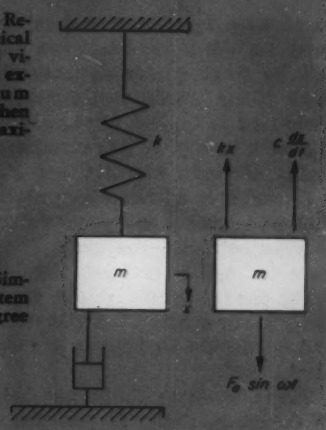
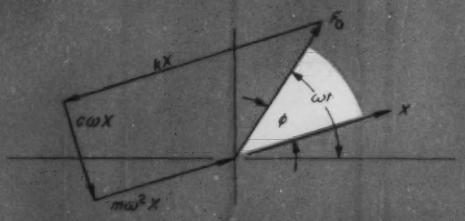


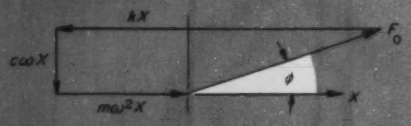
Fig. 2—Right—Simple vibrating system having a single degree of freedom

Nomenclature

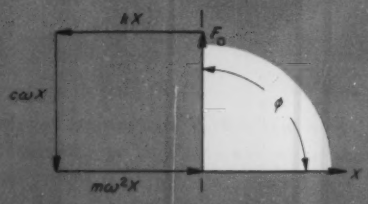
- c = Viscous damping coefficient
- F = Initial vibratory force
- F_0 = Steady state force supplied by shaker table
- F_1 = Input vibratory force supplied by shaker table, $F_0 \sin \omega t$
- F_2 = Output vibratory force, $F_1 \times$ resonant magnification factor
- f = Frequency of vibration, cps
- k = Spring modulus
- m = Mass of specimen
- t = Time
- X = Steady state displacement
- ϵ = Strain, in. per in.
- ϕ = Phase angle between displacement and applied force
- ω = Frequency of vibration, rad per sec



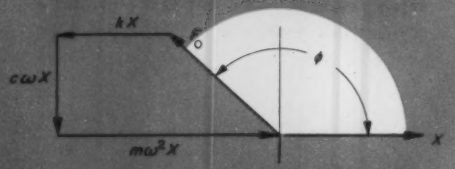
a—Phase-angle relationship based on Equation 1. Steady-state displacement, X, lags applied force, F_0 by angle ϕ which can vary from 0 to 180 degrees.



b—Phase-angle relationship at frequencies well below resonance. Both the inertial and damping terms are small, resulting in a small angle ϕ.



c—Phase-angle relationship at resonance. Angle ϕ=90 degrees.



d—Phase-angle relationship at frequencies well above resonance. Inertia force becomes large and is opposed by applied force.

Fig. 3—Relation of phase angle to displacement and vibration forces

posed to a spectrum of forcing frequencies, care must be taken to determine the condition which will be most severe dynamically and which will most likely cause mechanical deterioration. Response of a typical structure to forced vibration is shown in Fig. 1. The structure experiences maximum dynamic stress when F_2/F_1 is maximum.

Abruptness of the curve at the peaks indicates that an accurate frequency determination is necessary to establish the peak. If resonant frequency were defined slightly to the left or right of the peak, the structure would experience a substantially lower stress when vibrated at that frequency, and endurance or fatigue life would not be validly established.

Three basic methods are being used presently to detect resonant frequencies of structures during testing.

Strobe-A-Lux Lamp: At relatively low frequencies of 50 to 200 cps and with an applied vibration force of 10 g, response of a simple structure can be seen clearly with a Strobe-A-Lux lamp. At this acceleration, displacement of the shaker table is 0.004 in. double amplitude. Assuming a resonant magnification of five, induced displacement of the structure would equal 0.020 in. double amplitude at antinodal points. This displacement can be observed clearly, and the tester can accurately define resonant frequency of the structure. However, at frequencies above 200 cps, displacement of the structure normally becomes so small that it cannot be seen clearly.

At lower frequencies, assuming constant applied acceleration and structural magnification, induced displacement is larger because shaker-table displacement varies inversely as the square of applied frequency. Thus, at low frequencies, the strobe light permits detailed study of structural response.

When viewing a complex structure with a strobe light, the entire structure appears to be at resonance. It is not possible to detect which member is causing excessive response of the structure, and which members are being driven by the resonant one. Frequency limitations of the strobe light also preclude its use in many situations.

Audible Detection: A second method commonly used, particularly on totally enclosed structures, consists of listening for the buzzing noise which generally comes from a structure vibrating at resonance. This technique is at times combined with observation of the steadiness of the shaker table console displacement indicating meter. At resonance, effective mass of a test specimen is suddenly reduced. With constant power applied to the table, displacement of the shaker table rises abruptly when this occurs.

The audible detection technique, when applied to complex structures, reveals nothing more than the frequency range within which the structure

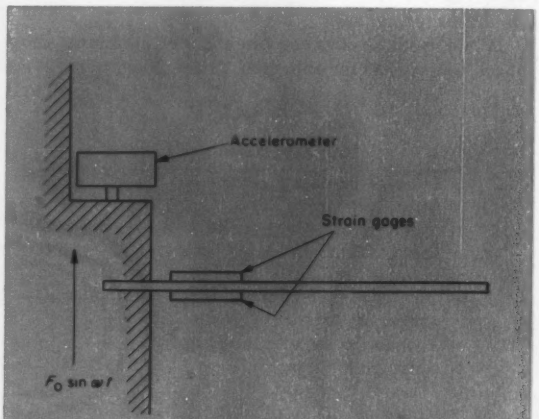


Fig. 4—Strain gages mounted on simple cantilever. Gages sense strain as a function of phase angle ϕ. Accelerometer senses force $F_0 \sin \omega t$.

develops resonance. It is impossible to determine even specific frequency.

Accelerometer: A third technique makes use of a force-sensitive accelerometer mounted on the test specimen. Voltage output of the accelerometer is monitored by an oscilloscope. In this manner, a complete resonance curve can be obtained over a frequency spectrum for the monitored point on the specimen.

The accelerometer technique fails, however, for multimember structures. An accelerometer senses force, not resonance. If the force is being transmitted from an adjacent resonant member through the structure to the accelerometer, the accelerometer cannot discern this fact.

Phase-Angle Method

To explain the phase-angle concept, the case of a simple mass having a single degree of freedom and subjected to forced vibration will be considered, Fig. 2.

The equation of motion is

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F_0 \sin \omega t \qquad (1)$$

Steady-state oscillation is represented by a particular solution expressed as

$$x = X \sin(\omega t - \phi) \qquad (2)$$

By substitution of this solution into the differential equation of motion, X and ϕ are determined

$$\frac{dx}{dt} = \omega X \cos(\omega t - \phi) = \omega X \sin\left(\omega t - \phi + \frac{\pi}{2}\right) \qquad (3)$$

$$\frac{d^2x}{dt^2} = -\omega^2 X \sin(\omega t - \phi) = \omega^2 X \sin(\omega t - \phi + \pi) \qquad (4)$$

Rearrangement of terms in the substitution gives

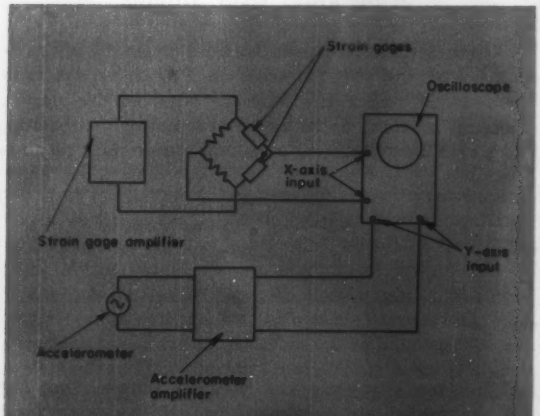


Fig. 5 — Instrumentation of strain gages and accelerometer. Resulting phase relationship between $F_0 \sin \omega t$ and X becomes visible on oscilloscope screen as varying Lissajous figures.

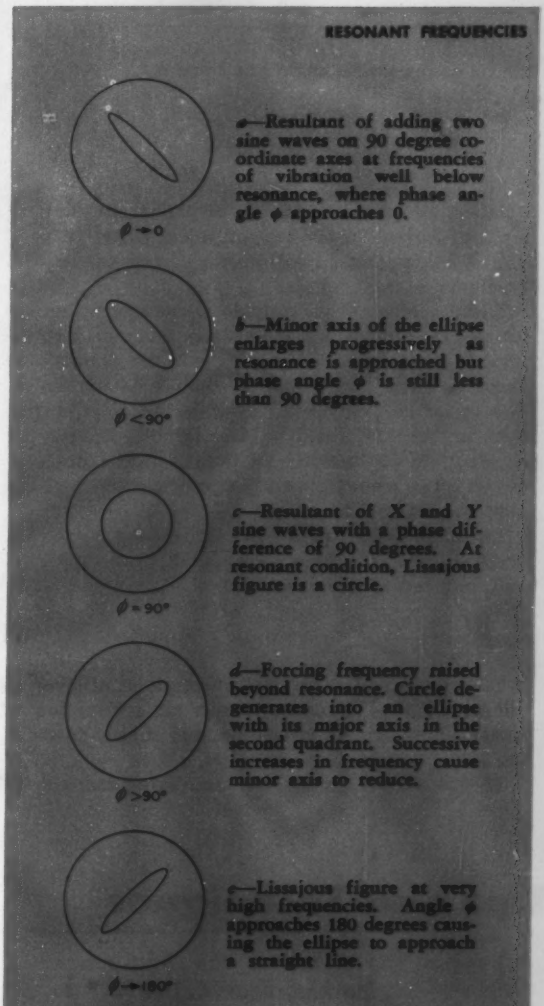

RESONANT FREQUENCIES
a—Resultant of adding two sine waves on 90 degree coordinate axes at frequencies of vibration well below resonance, where phase angle ϕ approaches 0.
ϕ→0
b—Minor axis of the ellipse enlarges progressively as resonance is approached but phase angle ϕ is still less than 90 degrees.
ϕ<90°
c—Resultant of X and Y sine waves with a phase difference of 90 degrees. At resonant condition, Lissajous figure is a circle.
ϕ=90°
d—Forcing frequency raised beyond resonance. Circle degenerates into an ellipse with its major axis in the second quadrant. Successive increases in frequency cause minor axis to reduce.
ϕ>90°
e—Lissajous figure at very high frequencies. Angle ϕ approaches 180 degrees causing the ellipse to approach a straight line.
ϕ→180°

Fig. 6—Lissajous figures on oscilloscope screen indicating exact degree of vibration and precise resonance conditions

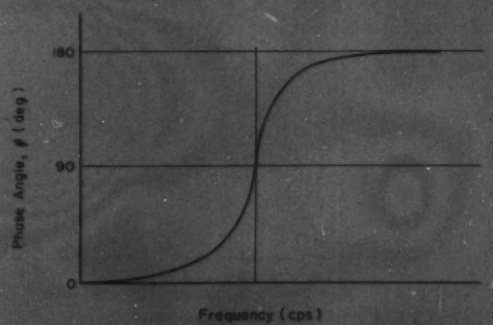


Fig. 7—Displacement phase-angle change for lightly-damped structures. Phase angle changes very rapidly in the vicinity of resonance. Resonant frequency is determined precisely and simply by high value of $d\phi/df$ at $\phi = 90$ degrees.

the following phase-angle relationship

$$m\omega^2 X \sin(\omega t - \phi) - c\omega X \sin\left(\omega t - \phi + \frac{\pi}{2}\right) - kX \sin(\omega t - \phi) + F_0 \sin \omega t = 0 \quad (5)$$

Relation of phase angle to displacement and vibration forces is shown graphically by vectors, Fig. 3. Phase-angle relationship at resonance, Fig. 3*c*, shows $\phi = 90$ degrees.

These relationships provide a convenient means for determining which member in a complex structure is at resonance and, as will be shown, the exact frequency at which resonance is maximum. The structure can then be subjected to vibration tests at this frequency to determine if fatigue life is adequate for service. If fatigue life is not adequate, the member can be redesigned, and its new frequency determined.

Dynamic strain in a vibrating body can be expressed as a function of applied vibratory force and induced displacement of the specimen

$$\varepsilon = f\left[\frac{F_2 \sin \omega t}{k} - X \sin(\omega t - \phi)\right] \quad (6)$$

Strain gages, mounted on a simple cantilever as shown in Fig. 4, sense strain as a function of phase angle ϕ. An accelerometer senses force $F_2 \sin \omega t$.

If the strain gages and accelerometer are instrumented as shown in Fig. 5, the resulting phase relationship between $F_2 \sin \omega t$ and $X \sin \omega t$ will be visible on the oscilloscope, Fig. 6. Lissajous figures seen on the oscilloscope indicate the exact degree of vibration and precise resonance conditions. Resonance occurs at $\phi = 90$ degrees, at which point the Lissajous figure is a circle, Fig. 6*c*.

Displacement phase angle changes very rapidly in the vicinity of resonance for lightly damped structures, Fig. 7. Therefore, the ellipse at $\phi < 90$ degrees will become a circle with only a slight change in frequency. The high value of $d\phi/df$ at $\phi = 90$ degrees makes it simple to determine resonant frequency precisely.

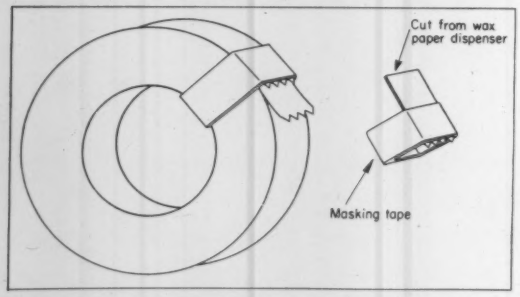
Because strain is a function of stress, it is advisable to place the strain gages at an area of high stress to get maximum signal. These areas can be determined either analytically or experimentally. Excellent results can be obtained by first stress-coating with brittle lacquer. A vibration scan over the test frequency spectrum will develop characteristic crack patterns which will define areas of high stress.

If the member of the test specimen being observed does not show characteristic Lissajous figures as the vibration frequency spectrum is traversed, and the member has a displacement greater than that supplied by the shaker table, excessive displacement is being caused by another member in the structure. The resonant member can be found by checking each member according to the outlined procedure.

Tips and Techniques

Masking-Tape Cutter

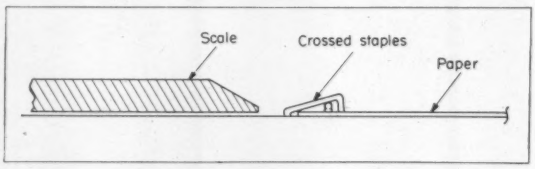
Tearing masking tape from the roll can be simplified and speeded by making a tape cutter. A section is cut from the saw-tooth metallic edge of



a wax-paper dispenser to make the cutter. The width of the section should be equal to, or slightly greater than, the width of the roll. Two short lengths of masking tape, with their gummed sides together, hold the cutter on the masking-tape roll but permit it to be moved readily around the roll. By holding the roll in the left hand, with the left thumb on the cutter, the desired length of tape can be pulled out with the right hand and readily torn off.—BLAISE D'ANKA, *Cleveland.*

Scale Rides Over Staples

When staples are used to hold paper to a drawing board, the vertical scale on a drafting machine may catch under the vertical edge of the paper, causing a torn drawing or requiring restapling. To avoid this problem, a second staple may be add-



ed horizontally over the vertical staple. One leg of the added staple should be off the paper and the second alongside the other staple. The staple produces a slightly inclined surface to lift the drafting-machine scale over the paper-holding staple.—JOHN MENTERS, *North Reading, Mass.*

Design in the Plastic Region

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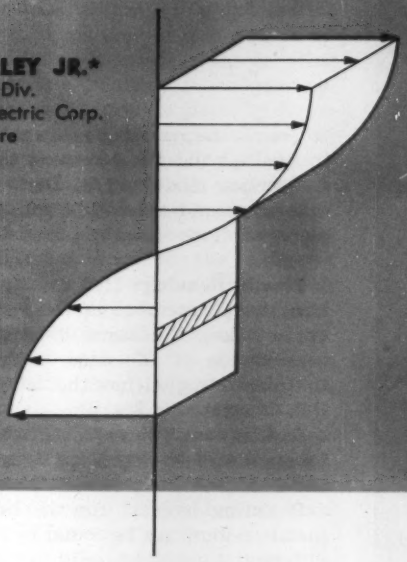


Weight and size advantages frequently result if design stresses can be selected in the plastic-deformation region — a concept long practiced in the aircraft industry. Key to possible use of the technique is found in the predicted load schedule: continuous normal-level static and vibration loads, plus statistically uncommon peak loads or overloads. Presented here are basic design relationships and a nomographic solution to the fundamental beam equation.

EXPERIENCE demonstrates that failure of mechanical structures often results from the action of shock and vibration, even when static-loading safety margins are ample. The material in such structures is usually hard, brittle, strong, and shows little elongation before failure. Furthermore, resistance to vibratory resonance is low.

Certain structural materials, however, stand up well under shock and vibration. Typical qualities exhibited by materials in this class are lightness, good damping characteristics, nonlinear response to vibratory excitation and large elongation under load without fracture. While possessing such favorable qualities, these materials often have low allowable stresses in tension and compression. This poses a design problem, since the structure must withstand not only the vibration load but also static loads with a margin of safety.

Design in the plastic region, using a material with comparatively low allowable stress and high elongation, offers a solution. The concept is not new. Aircraft structures have long been designed in the plastic region, and standard practices have been adopted.[1,2] This article reviews the fundamentals of the technique and presents a graphical solution for the basic design equation.

*Now Consulting Engineer, Baltimore, Md.
[1]References are tabulated at end of article.

The Beam Problem

Working equations derived in this article apply strictly to beams undergoing bending, since such structural forms are most commonly used in design. The basic theory, however, can be extended to torsion elements or plate design.

Elastic Bending: Form of the familiar elastic stress-strain diagram of a specimen in tension or compression is shown in Fig. 1. Tension and compression curves are assumed to be similar. How-

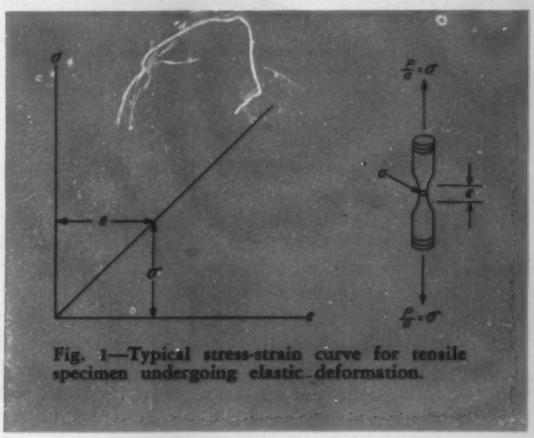


Fig. 1—Typical stress-strain curve for tensile specimen undergoing elastic deformation.

Nomenclature

A = Area of beam cross-section above neutral axis, sq in.
a = Area of tensile specimen, sq in.
b = Width of rectangular beam, in.
c = Distance from neutral axis to extreme outside fiber, in.
dA = Differential area of beam cross-section above neutral axis, sq in.
dy = Differential vertical distance, in.
h = Height of rectangular beam, in.
I = Moment of inertia, in.^{4}
k = Form factor
l = Length of beam, in.
M = Actual moment acting on beam, lb in.
m = Bending resisting moment, lb in.
m_a = Incremental resisting moment, lb in.
m_b = Incremental resisting moment, lb in.
P = Axial load on tensile specimen, lb
Q = First moment of cross-section of beam above neutral axis, in.^{3}
w = Uniform weight acting along beam, lb per in.
y = Distance from neutral axis to dA on cross-section of beam, in.
ϵ = Unit strain, in. per in.
σ = General symbol for tensile or compressive stress, psi
σ_a = Trapezoidal stress at neutral axis, psi
σ_b = Trapezoidal stress at extreme outside fiber, psi
σ_e = Stress in outside fiber for elastic bending, psi
σ_p = Stress in outside fiber for plastic bending, psi
σ_{ult} = Ultimate fiber stress, psi
σ_y = Yield fiber stress, psi

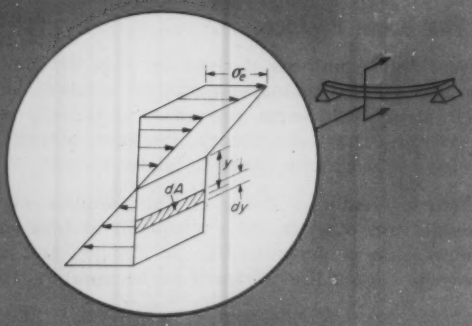


Fig. 2—Internal stress distribution for elastic bending.

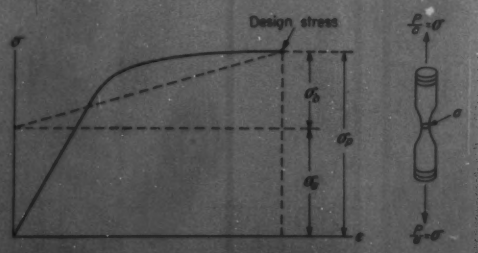


Fig. 3—Stress-strain relationship for specimen stretched into the plastic region.

ever, if a wide variation exists, Reference 2 can be used to obtain a satisfactory plastic analysis.

Stress distribution in a beam of the material with characteristics of Fig. 1 and subjected to a bending load is shown in Fig. 2. From elementary strength of materials,

$$\sigma_e = \frac{mc}{I} \tag{1}$$

or

$$m = \frac{\sigma_e I}{c} \tag{2}$$

where m, the resisting moment of bending, is found by multiplying the stress at the extreme fiber by the section modulus I/c. Derivation of Equation 1 ignores second-order differentials and assumes that plane sections remain plane after bending.

Plastic Bending: If a tensile specimen is pulled into the plastic region, the resulting stress-strain curve takes the form illustrated in Fig. 3. A beam made of the same material and bent into the plastic region has the internal stress distribution illustrated in Fig. 4.

In this case, the resisting moment can no longer be expressed by Equation 1, and the stress-strain curve cannot be assumed linear.

Resisting moment for the beam stressed in the plastic region can be found by: (1) expressing the differential area dA (Fig. 4) in terms of y, say, $\phi(y)$; (2) expressing values of stress σ in terms of y, say $\alpha(y)$; (3) integrating differential moments across the beam. The resulting moment equation is then

$$m = 2\int_0^A \sigma y \, dA \tag{3}$$

or

$$m = 2\int_0^c \phi(y)\, \alpha\,(y)\, y \, dy \tag{4}$$

Stress Trapezoid: Cozzone has originated a unique approach[1] to this problem with the follow-

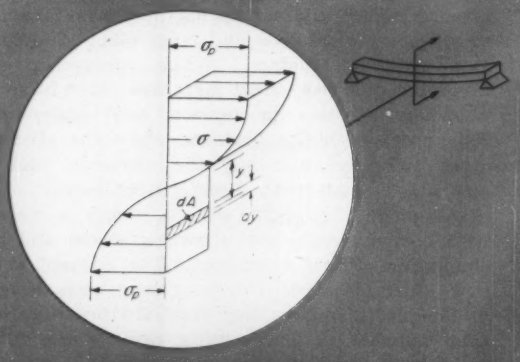


Fig. 4—Internal stress distribution for plastic bending.

ing limitations: (1) The neutral axis must be in the center of the beam; (2) Tensile stresses of bending must be similar to compressive stresses of bending. Many structures can be satisfactorily analyzed within these limitations. The degree of variation from the ideal can be studied for a particular application and the errors brought within tolerable limits.

In the Cozzone method, actual stress distribution in the beam, Fig. 4, is reduced to the equivalent trapezoidal stress distribution of Fig. 5. This trapezoid has the same bending resistance, expressed as a moment resistance, as given by Equation 4. Stress dimensions of the trapezoid are calculated by pulling a specimen, Fig. 3, and recording the actual stress-strain curve. A trapezoid is then constructed so as to give the same moment about the neutral axis as the moment of the actual stress-strain curve transferred to the deflected beam. This operation can be performed numerically, graphically, or on an automatic computer. Stress co-ordinates so determined are marked σa, σb and σp on the trapezoid. If the specimen is pulled to the yield point, then the yield stress σy of the specimen equals σp.

When this material is made into a beam and bent, the trapezoidal stress curve, representing the beam stress distribution, has the form shown in Fig. 5. If the beam is bent to the yield point, then σ_p equals the yield stress and σ_a is a fictitious stress and is used only in computations that give the bending resistance of the beam. Stresses plotted in Fig. 5 are not true stresses, but simply simulated trapezoidal stresses that permit calculation of actual beam bending resistance when the extreme fiber is stressed to the yield point. Any other design stress in the plastic region can, of course, be substituted for the yield-point stress.

Resisting Moments: The stress trapezoid, Fig. 5, develops a resisting moment that can be expressed as

$$m = m_a + m_b \tag{5}$$

In Equation 5, m_a is the bending resisting moment developed by the rectangular stress solid with uniform stress σ_a across the entire section; m_b is the resisting moment developed by the triangular stress solid with maximum stress σ_b. Moments m_a and m_b are given by

$$m_b = \frac{\sigma_b I}{c} \tag{6}$$

and

$$m_a = 2\,\sigma_a\,Q \tag{7}$$

It is seen that Equation 1 gives the bending resisting moment m_b. Moment of the uniform stress σ_a about the neutral axis is given by Equation 7, where Q is the first moment of the part of the cross-section above the neutral axis. The expression for Q is

$$Q = \int_0^c y\,dA \tag{8}$$

Relationship between the stresses is given by

$$\sigma_b = \sigma_p - \sigma_a \tag{9}$$

Also, from Equation 5,

$$m = \frac{(\sigma_p - \sigma_a)\,I}{c} + 2\,\sigma_a\,Q \tag{10}$$

Then

$$m = \frac{\sigma_p I}{c} + \sigma_a\left(2\,Q - \frac{I}{c}\right) \tag{11}$$

Dividing by I/c,

$$\frac{mc}{I} = \sigma_p + \sigma_a\left(\frac{2\,Qc}{I} - 1\right) \tag{12}$$

Here, mc/I is the resisting moment divided by the section modulus I/c.

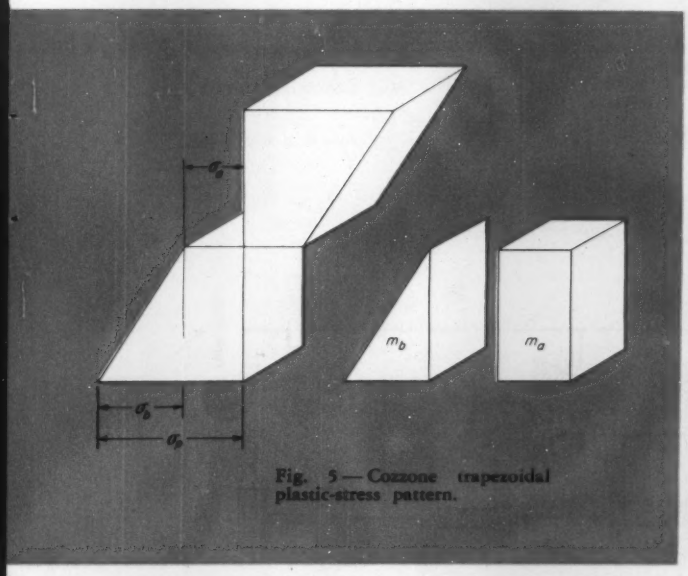


Fig. 5 — Cozzone trapezoidal plastic-stress pattern.

Form Factor: In Equation 12, the term

$$\frac{2\,Qc}{I}$$

depends only on section geometry and can be written as

$$\frac{2\,Qc}{I} = \frac{2\,c\int_0^c y\,dA}{\int_0^c y^2\,dA} = k \tag{13}$$

The quantity k is called the form factor.

Since the form factor is independent of stress, its value can be determined for rectangular, tubular, hour-glass, diamond and similar geometric configurations by use of calculus or by numerical techniques. Typical cross sections have been calculated and k values are shown on the nomograph in Fig. 6. From the nomograph, it is noted that k for a rectangular beam is 1.5. Value of k for an I-beam of infinitely small web is 1.0. With a little experience, a value for k for any type of I-beam

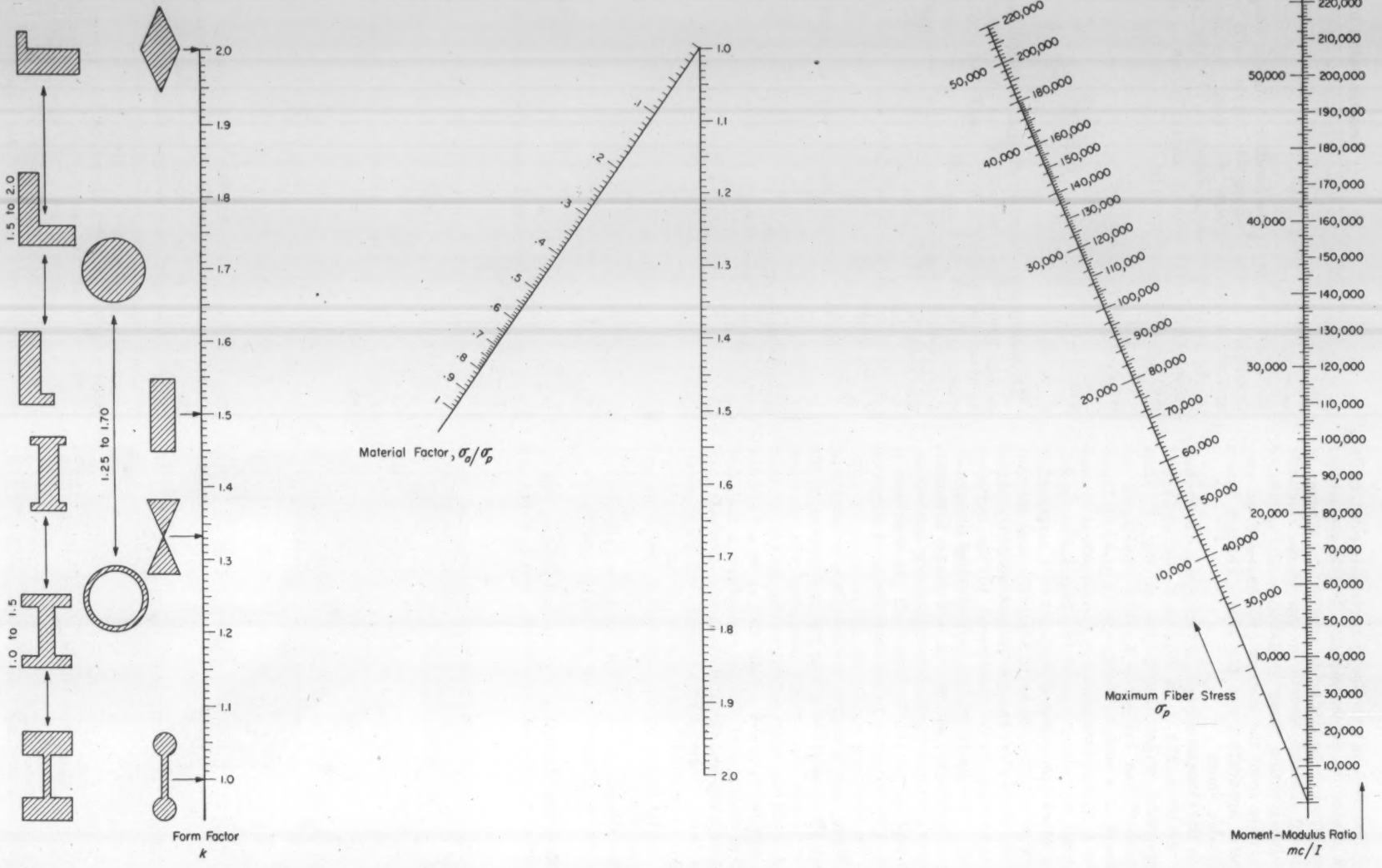


Fig. 6--Nomographic solution to Equation 15.

with varying web thickness can be closely estimated. A channel section has the same value of k as an I-beam and therefore is not shown on the nomograph.

In preliminary design, it may be necessary to pick out the most advantageous circular cross-section for a beam, say, either a solid rod or a thin-walled tube. As the nomograph shows, value of k for a solid rod is 1.7; k for thin-walled tube is approximately 1.25. The most efficient section can be immediately bracketed by finding the resisting moment directly on the nomograph as demonstrated in a following section. The exact value of k can be integrated prior to final layout design.

Nomograph Solution: Equation 12 can be reduced to a form that permits a nomograph to be constructed for its solution. Rewriting Equation 12,

$$\frac{mc}{I} = \sigma_p + \sigma_a (k - 1) \qquad (14)$$

which can be written

$$\frac{mc}{I} = \sigma_p \left[1 + \frac{\sigma_a (k - 1)}{\sigma_p} \right] \qquad (15)$$

Example: Beam of length l = 25.3 in. supports uniform load w = 10 lb per in. Cross-section dimensions are: b = 0.18 in.; h = 0.577 in. Material factor (4130 normalized) σ_a/σ_p = 0.600; yield stress σ_p = 70,000 psi. Form factor k = 1.5 (from nomograph).

BENDING MOMENT:

$$M = \frac{wl^2}{8} = \frac{10\ (25.3)^2}{8} = 800 \text{ lb-in.}$$

SECTION MODULUS:

$$\frac{I}{c} = \frac{bh^2}{6} = \frac{0.18\ (0.577)^2}{6} = 0.01 \text{ in.}^4$$

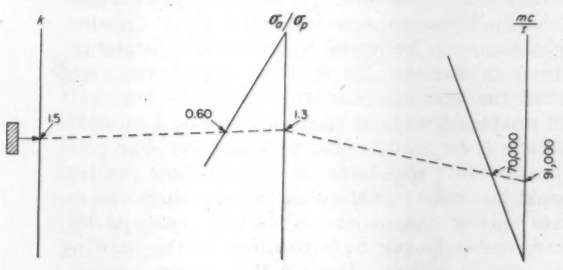
From nomograph:

Allowable m = 91,000 (0.01) = 910 lb-in.

Actual M = 800 lb-in.

$$\text{Margin of Safety} = \frac{910}{800} - 1$$

$$= 0.14$$



Nomographic solution for Equation 15 is shown in Fig. 6. The mathematical operation performed is that 1 is first subtracted from k. This term is then multiplied by σ_a/σ_p. Next, 1 is added to the result. Results of these operations are listed on the vertical scale in the center of the nomograph.

The last mathematical step of the nomograph is to multiply the value in the center line, or

$$1 + \frac{\sigma_a (k - 1)}{\sigma_p}$$

by the term σ_p. Resisting moments of bending mc/I are tabulated on the right hand vertical column. Values of σ_p and mc/I are listed on both sides of the vertical and diagonal lines. Values of σ_p on the left side of the diagonal line correspond to mc/I values on the left side of the vertical line. If σ_p is above 200,000 psi, then the left side of the diagonal line is used, since a zero is automatically added to both the left side of the diagonal σ_p line and the left side of the vertical mc/I line.

The complete solution of the nomograph is the mc/I term in Equation 15. The term can be multiplied by the section modulus I/c to give the resisting moment m of the beam. Margin of safety can be calculated by comparing the resisting moment m of the beam with the actual moment M of the beam, or

$$\text{Margin of Safety} = \left(\frac{m}{M} - 1 \right)$$

Material Factor: The left-hand diagonal line on the nomograph lists values of the material factor σ_a/σ_p. Examination of Fig. 3 shows that the material factor describes, to some extent, the shape of the plastic region of the stress-strain curve for a particular material.

Table 1—Typical Material Factors

Material	Yield Material Factor	Ultimate Material Factor
Magnesium sand casting	0.396	0.491
Magnesium forging	0.380	0.678
Alloy steel	0.500	0.950
4130 normalized steel	0.600	0.905
Aluminum sand casting	0.420	0.750
Aluminum 2014	0.420	0.900
Aluminum 2024	0.440	0.850

In preliminary layout, the material factor can be estimated from previous work. For exact results the factor should be calculated for each production mill run. Representative material factors, calculated from typical mill runs, are given in Table 1. If the beam is designed to the yield-point stress, the yield material factor (Table 1) is used. If the beam is designed to the ultimate stress, the ultimate material factor is used.

Listed on the right-hand diagonal scale of the nomograph are values of σ_p, the stress in the extreme fiber of the beam undergoing bending. If the beam is designed to the yield point, σ_p equals

σ_y, which is the yield stress of the material. If the beam is stressed to the ultimate, then σ_p is equal to σ_{ult}, the ultimate stress of the material.

Nomograph Limitations

The nomographic solution for plastic bending has these limitations: (1) sections must be symmetrical about the neutral axis, and (2) the stress-strain curve of the material undergoing bending must be approximately the same in tension as in compression. Other limitations inherent in the derivation are similar to those that hold for the elastic-bending case. They include:

1. Beam curvature should be small in order that differentials of the second order can be safely neglected. For beams of small curvature, results of Reference 3 can be used in conjunction with this method.

2. Derivation of the bending equation assumes that beam cross-sections remain fairly uniform along its length. Reference 3 can be used to calculate the change in stress due to a change in cross section for elastic bending. For reasonably small section changes, the plastic-bending results can be used if allowance is made for the change in stress with change in cross section. Sections of the beam where the cross-section is uniform can be stressed in the plastic region and analyzed by this technique.

3. At points of combined stresses, such as at a load-application point, this analysis cannot be used.

4. Many stress-strain curves show a hook or other form of discontinuity. For most design problems a trapezoid can still be drawn from the stress-strain curve to give the resisting moment. Reference 2 is recommended for a complete material analysis of such curves.

5. Residual stresses, prestressing and similar effects which arise during fabrication can cause a discrepancy in the analysis. In some cases, the initial stress caused by manufacturing can be added to or subtracted from the stress due to bending. Extreme care, however, must be taken to ascertain these values and to determine their effects on the material. A combination of prestressing and section discontinuities, for example, holes or abrupt changes in cross section, often further complicates the problem. Only experience, verified from tests, can reveal the exact limits of the analysis for such special cases.

6. The nomograph solution cannot be used effectively where combined bending occurs simultaneously in two planes. Reference 1 has listed a technique by which this problem can be worked out. Since this system of analysis is merely one of numerical integration, approximate solutions can be worked out in preliminary design where bending is predominant in one plane, and where σ_a approaches σ_p as a limit.

Other Applications

Equation 15 gives a value for resisting moment divided by section modulus. When the margin of safety equals zero, the resisting moment equals the actual moment. In such a case—for example, in preliminary design analysis—the nomograph can be used to solve for the allowable design stress. If the material allowable stress is entered in the right diagonal column in Fig. 6, the right-hand vertical column gives mc/I, the allowable design stress. A word of caution however: margins of safety cannot be computed by this technique since the basic function is not linear.

Such an application of the nomograph is particularly helpful where a typical section modulus has been selected and the only variable left is selection of a suitable material as indicated by the allowable stress. When the material has been selected, the margin of safety can be computed by comparing resisting moment given by the nomograph.

Horowitz has developed a technique[2] for calculating the resisting moment of a beam when: (1) the cross-section of the beam is not symmetrical, and (2) the material does not exhibit the same properties in tension as in compression. In this technique, the center of gravity of the nonsymmetrical cross section is assumed to be at the neutral axis of bending. The stress-strain curve is then sketched vertically through the beam. Graphical integration gives the resisting moment, which is the product of incremental stresses times incremental areas. The error in most cases is small. Automatic computers can perform this function directly, and design changes can be optimized on the machine.

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2. M. Ish Horowitz—"Moment of Resistance of Beams Stressed Beyond the Elastic Limit," *Aircraft Engineering* (British), January, 1951, Page 9.
3. J. A. Van Den Broek—*Theory of Limit Design*, John Wiley & Sons, New York, 1948.
4. R. E. Peterson—*Stress Concentration Design Factors*, John Wiley & Sons, New York, 1952.

Tips and Techniques

Lettering on Large Drawings

When lengthy, detailed parts lists, specifications, or instructions must be included on a drawing, much time can be saved by doing the "lettering" with a typewriter. To do this, cut off the right end of the drawing, just left of the title box. This will produce a strip of paper about 6 or 8 in. wide, which will fit readily into a typewriter. For good reproduction, standard or orange-face carbon should be used to produce an impression on the reverse side of the paper. When the typing is finished, the strip can be butt-joined to the drawing with mending tape.—ROBERT E. GREENE, *superintendent, Sonic Research Corp., Boston.*

Method of Finite Differences in

CAM DESIGN

- **Accuracy**
- **Applications**

By RAY C. JOHNSON
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THE theory of finite differences is an approximate but accurate method which can be used in the design and analysis of cams to calculate acceleration directly from displacement.[1] Since cams must be designed and manufactured with an extremely high degree of precision for high-speed machinery, the designer might question the suitability of this method because of its approximate nature.

It is the twofold purpose of this article to illustrate the high degree of accuracy of finite differences for cam design, and to call attention to those regions in the field of high-speed cams where applications of this theory can be most effective.

Theoretical Cams vs. Manufactured Cams: In developing cam motion, the designer focuses his attention on a curve of theoretical motion, i.e., constant acceleration, cycloidal, polydyne, etc. This theoretical motion will be referred to as the primary component from which displacement values are calculated. For most cases, these displacement values, with tolerance limits, and a request for a smooth surface are the only specifications submitted to the shop for manufacturing a cam.

From a primary component standpoint, the manufacturer develops a physical cam on which a smooth curve exists between any given three adjacent displacement points. This condition assumes the step-mill procedure commonly used for manufacturing high-speed cams. Development of primary motion by finite differences is also based on the assumption of a smooth curve existing between any three adjacent points.

Because of inherent imperfections, a cam imparts to the follower a total motion which consists of a secondary component as well as the primary component. The secondary component is due to surface imperfections and manufacturing errors. From an acceleration standpoint, this secondary component can be very appreciable with respect to the primary component.

Unfortunately, it is impossible to manufacture a cam having no secondary component. Surface imperfections can be avoided, but small machining errors cannot. Severe secondary acceleration fluctuations in the cam mechanism are caused by follower body displacement errors of a few ten-thousandths of an inch and cam angle errors of a few seconds.[2] Although secondary acceleration components are unavoidable since they are independent of the primary component, they are controlled to tolerable values by careful design and workmanship. [1, 2] Therefore, the designer is justified in focusing attention on the primary component in motion development. If the primary component is smooth, a smoother resultant motion will most likely occur for a given fluctuating secondary component.

Accuracy of Finite-Differences: Several classes of primary motions are frequently used in high-speed cam design, i.e., constant acceleration, sinusoidal or cycloidal, constant pulse (linear acceleration), and other polynomial relationships in gen-

[1]References are tabulated at end of article.

eral. Sample follower body displacement values will be determined from primary equations of various classes, and finite-difference accelerations will be calculated using different cam-angle intervals to determine the effect of cam-angle interval size. Finite-difference accelerations will be compared with exact accelerations obtained by mathematical methods.

Typical smooth primary cam motion curves are expressed as equations of $s = f(\theta)$, where s is follower body displacement, and θ is the cam angle. Let displacements for any three adjacent points specified $\Delta\theta$ degrees apart, be denoted by s_1, s_0, and s_2, where s_0 is the point under consideration. According to basic theory, acceleration a_0 at point s_0 is

$$\frac{a_0}{\omega^2} = \left(\frac{d^2 s}{d\theta^2} \right) \qquad (1)$$

where ω is the angular velocity of the cam.

Applying the theory of finite-differences to the displacements and keeping the same units as in Equation 1, acceleration a_0 at point s_0 is

$$\frac{a_0}{\omega^2} = \frac{s_1 + s_2 - 2s_0}{(\Delta\theta)^2} \qquad (2)$$

The following primary motion curves, which are typical of those used in cam design, have been analyzed:

1. $s = K \sin \theta$
2. $s = K\theta^2$
3. $s = K\theta^3$
4. $s = K(\theta^3 + \theta^2)$
5. $s = K\theta^5$

where K is any constant.

For each equation, accelerations have been calculated from Equation 1. From calculated displacements, finite-difference accelerations have been determined from Equation 2 for various cam-angle intervals. Error in the finite-difference method has been calculated for various cam-angle intervals. Results are shown in Table 1 from which the following conclusions may be drawn:

1. For constant acceleration or constant pulse, or for combinations of the two, the finite-difference method is exact for calculating accelerations.

2. Errors due to finite-difference approximation are independent of the slope of the acceleration curve as shown by the constant pulse and sinusoidal examples.

3. If finite-difference approximation errors exist, they increase with cam-angle intervals. This is apparent from the sinusoidal example shown, in which an error increases from nearly negligible for a cam-angle interval of 3 deg to 2.1 per cent for a cam-angle interval of 30 deg.

4. For simple polynomial curves and a given cam-angle interval size, finite-difference errors increase with the power of the polynomial.

5. For simple polynomial curves and a given cam-angle interval size, finite-difference errors de-

Table 1—Cam-Angle Interval Effect on Finite-Difference Accuracy

Cam Angle (deg)	Theoretical Acceleration (Eq. 1)	Finite Difference Acceleration (Eq. 2)											
		Δθ = 1 deg	Error (per cent)	Δθ = 3 deg	Error (per cent)	Δθ = 5 deg	Error (per cent)	Δθ = 10 deg	Error (per cent)	Δθ = 20 deg	Error (per cent)	Δθ = 30 deg	Error (per cent)
$S = K \sin \theta$; (simple harmonic, cycloidal)													
30	−0.500K	−0.492K	1.6	−0.501K	0.2	−0.500K	0.0	−0.498K	0.4	−0.493K	1.0	−0.488K	2.2
60	−0.866K	−0.855K	2.2	−0.869K	0.4	−0.867K	0.1	−0.863K	0.4	−0.859K	0.8	−0.848K	2.1
90	−1.00K	−0.985K	1.5	−1.000K	0.0	−1.000K	0.0	−0.996K	0.4	−0.990K	1.0	−0.979K	2.1
$S = K\theta^2$; (constant acceleration)													
30	2K	2K	0.0	2K	0.0	2K	0.0	2K	0.0	2K	0.0	2K	0.0
•													
$S = K\theta^3$; (constant pulse)													
30	180K	180K	0.0	180K	0.0	180K	0.0	180K	0.0	180K	0.0	180K	0.0
•													
$S = K(\theta^3 + \theta^2)$; (simple polynomial)													
30	182K	182K	0.0	182K	0.0	182K	0.0	182K	0.0	182K	0.0	182K	0.0
$S = K\theta^5$; (simple polynominal)													
30	540,000K	540,300K	0.0	543,700K	0.5	547,946K	1.4	570,000K	5.6	....	..	....	..

*Same accuracy for any angle

crease as acceleration magnitude increases.

6. For small cam-angle intervals, finite-difference errors are insignificant for examples studied.

Application of Finite-Differences: For effective application of the theory of finite differences, the following points which summarize its limits of application and degrees of accuracy must be understood:

1. The theory of finite differences is a rapid[1, 3] and accurate method for designing cam profiles, and is suitable for developing primary motions with desirable acceleration characteristics.

2. Secondary effects due to machining errors, which are not precisely controlled, are not accurately predictable by the theory of finite differences.[2] In fact, only an average maximum acceleration fluctuation can be predicted, and it is possible that the accuracy of prediction will not be high. The method of finite differences makes it possible in design to choose a cam-angle interval such that the secondary effects of machining errors are mitigated to tolerate values. However, this method is the only one available for such a prediction. Moreover, inaccuracy of prediction is inherent to the manufacturing method. Generally, a rough prediction of secondary effects is better than no prediction.

3. The method of finite differences can be used in analysis of cams for accurately predicting accelerations from given and calculated displacements. Small fluctuations might exist on primary motion accelerations so calculated because of the practice of rounding off displacement values to four decimal places.

4. Finite differences will not accurately predict, from measured displacement values of an existing cam, the total accelerations which result in operation of the cam. Since primary and secondary components exist and are inseparable, the secondary effect will distort a smooth primary motion. Follower displacement errors and cam-angle errors[2] inherent to any measuring technique, introduce another secondary effect on accelerations calculated from measured displacements.

If a very small cam-angle interval is used for displacement measurements, measuring errors will be very significant since acceleration fluctuations so introduced, vary inversely[2] as $(\Delta\theta)^2$.

A very small cam-angle interval means an interval smaller than that used for step-milling the cam. If a larger cam-angle interval is used for measuring displacements, the secondary component leads to significant errors when attempting to predict total actual acceleration at a point from displacement measurements.

This statement is true since, for larger cam-angle intervals, the actual cam contour curve between the three adjacent points used in measurements is not smooth as assumed by the finite-difference equation derivation.[1]

5. Application of finite differences to displacement values measured from an existing cam will not accurately correlate with theoretical primary accelerations. Machining errors and errors in measured displacement values explain the lack of correlation.

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2. R. C. Johnson—"Cam Dynamics," MACHINE DESIGN, Vol. 29, No. 3, February 7, 1957, Pages 105-108.
3. R. C. Johnson—"Cam Profiles," MACHINE DESIGN, Vol. 28, No. 25, December 13, 1956, Pages 129-132.

Tips and Techniques

Preventing Ink Smears

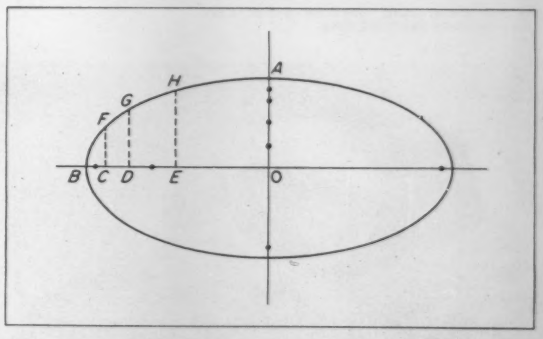
Triangles and other plastic drawing guides may be raised above the drawing paper by placing a small drop of cellulose-nitrate adhesive, such as Duco cement, in each corner of the piece. After drying, similar drops are placed on the opposite side of the guide. If the part is large, intermediate spots of cement may be necessary to prevent sagging.—LEON KASSEL, *Military Sea Transportation Service, Brooklyn, N. Y.*

Drawing Ellipses

Approximate but useful ellipses can be drawn easily and with little construction when it is remembered that for any ellipse, the following close approximations apply:

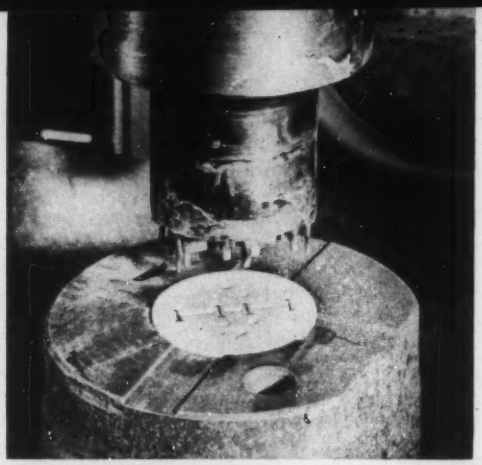
When $BC = BO/8$, $CF = AO/2$
When $BD = BO/4$, $DG = 2\ AO/3$
When $BE = BO/2$, $EH = 7\ AO/8$

Using these values, points may be plotted and



an ellipse constructed if its two major dimensions are known. The values of distances *CF*, *DG*, and *EH* are accurate to within 3, 1, and 1 per cent, respectively.—V. E. GARDNER, *Arlington, Va.*

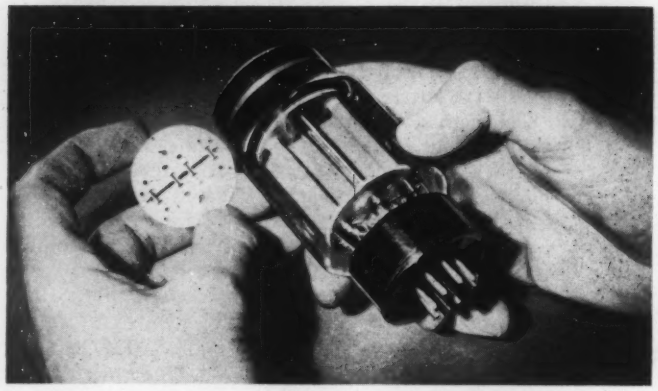
ULTRASONIC MACHINING

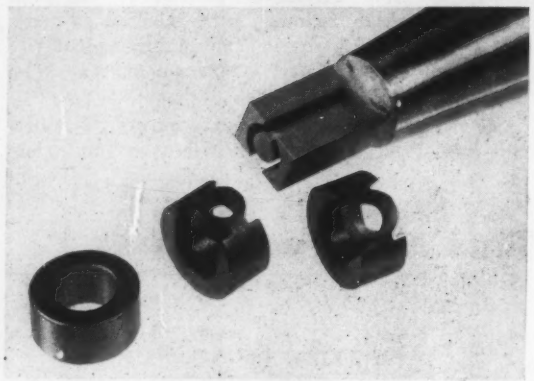


Developed only a few years ago, ultrasonic machining permits designing holes and intricate surfaces in materials that are nonmachinable by conventional cutting operations.

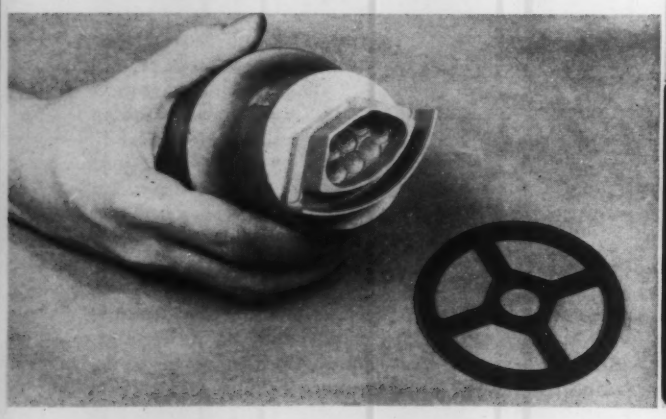
Among the materials readily cut by this process are glass, ceramics, carbide, germanium, silicon, gem materials, quartz, hardened steel, ferrite, steatite, aluminum oxide, ferramic and diamonite. Regardless of the material cut, its appearance and physical properties remain unchanged. Cavitation does not result in burning, discoloration, distortion, or stress buildup. The ability to cut hardened tool steel and carbide permits design of parts with complex internal contours without splitting the part to give access to grinding or lapping wheels. In addition, holes or surfaces produced after hardening are not dislocated or warped during heat treat, do not induce stress concentrations, and do not require cleaning of scale or oxidation.

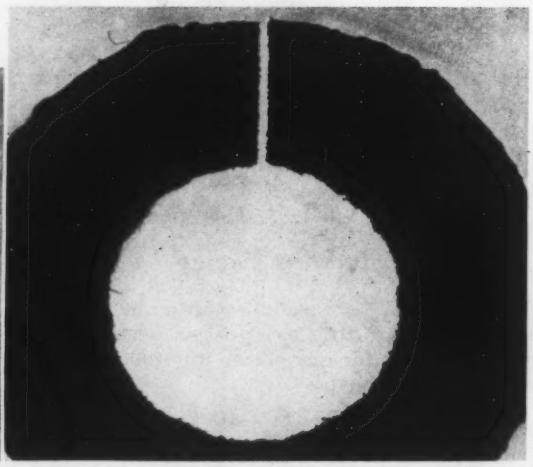
Accuracy and surface finish are very good. Conventional roughing cuts can achieve tolerances of $\pm$ 0.0005 in. with a finish of 25 mu in. rms. If finer finishes are required, a diamond-paste slurry can be used for finishing cuts, producing a finish of about 10 mu in. Relationship between holes can be maintained within 0.001 to 0.0005 in. With carbide or tool-steel parts, conventional lapping may be used after ultrasonic machining to produce a mirror finish and give any degree of precision required. Illustration at lower right shows magnification of a .0015-in slot cut in ferrite.

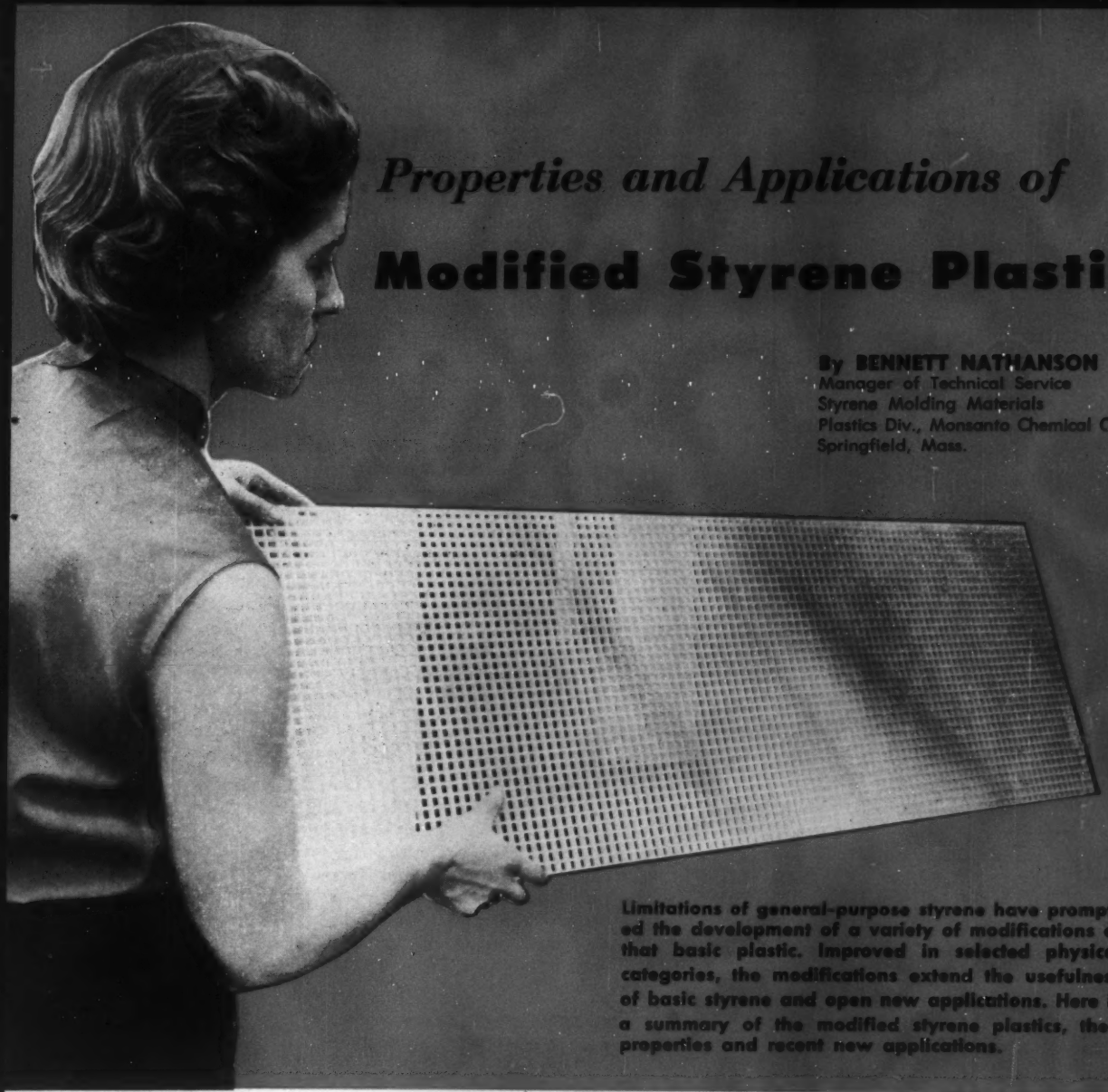




Top two illustrations, courtesy C-Mar Corp., others courtesy Sheffield Corp.







Properties and Applications of
Modified Styrene Plastics

By **BENNETT NATHANSON**
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Styrene Molding Materials
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Limitations of general-purpose styrene have prompted the development of a variety of modifications of that basic plastic. Improved in selected physical categories, the modifications extend the usefulness of basic styrene and open new applications. Here is a summary of the modified styrene plastics, their properties and recent new applications.

MODIFICATIONS of general-purpose styrene give designers and manufacturers end-use characteristics of greater toughness, higher heat resistance and improved chemical resistance. Types, physical forms and applications of these modified styrenes include tough rubber-modified molding materials, high-impact styrene sheets used extensively in vacuum forming, oriented styrene sheets with exceptional strength properties, and styrene - acrylonitrile copolymers with excellent chemical resistance. Further variations of these products yield materials which combine high impact strength with high heat resistance, medium impact strength with high heat resistance, a super high impact material, and a static-dissipating styrene.

Why were these materials developed and what use may be made of their unique properties?

Fig. 1—Top—Soft-flow, general-purpose styrene is injection-molded to form a lighting louver by Edwin E. Guth Co.

▶ Processes and Properties

Refinement of the injection molding process to develop greater speeds and higher automation has been a major factor in the progressive development of modified styrene molding materials. The injection molding process—basic production

technique of thermoplastic molding—has progressed in the past few years to the point where mechanical operation of the machine and periods in its production cycles are now measured in microseconds, not just seconds. Injection speeds, governed by the forward movement of the injection ram, approach 1200 linear in. per minute.

Since the total distance traveled is never more than 12 to 18 in., the bottoming time is measured in microseconds. This type of mechanical action places a tremendous strain not only on the machine but on the molding materials.

Three years ago, general-purpose styrene could not be molded under these conditions. As molding speeds increased, reformulation of styrene for better moldability became a necessity. Higher speeds are now achieved in two ways: (1) by lowering the average molecular weight and (2) by lowering slightly the heat distortion temperature.

The result of these modifications is a lower melt viscosity, and consequently a material of good processability. Most important, the modifications are made without a sacrifice in properties which might exclude practical end-use employment. An example of this is the manufacture of a soft-flow general-purpose styrene, the heat distortion temperature of which has been lowered to approximately 170 F from an average of 185 F, Fig. 1.

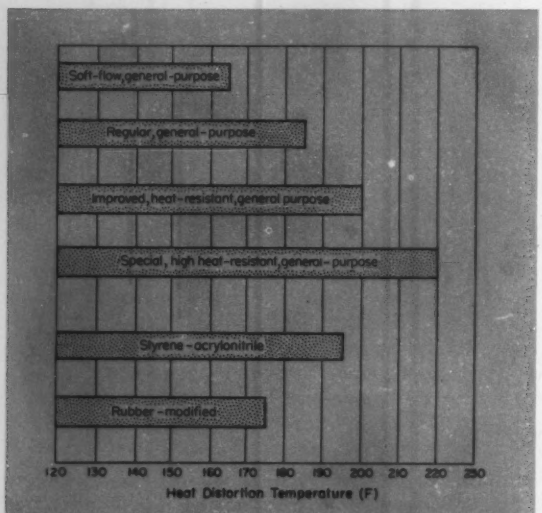

Fig. 2—Comparative heat distortion of styrene plastics, with and without additives.

Rapidly increasing use of styrene molding materials in industrial applications is a second factor spurring the development of new styrenes. Needed particularly are polymers with increased heat resistance, Fig. 2. Applications include standby electrolytic battery jars, radio cabinets and fan blades. The polymers in these products have heat resistance in the range of 195 F to 200 F. Other applications require a styrene with resistance to temperatures over 212 F to resist boiling water. These are inherently stiffer molding compounds and slightly slower to mold, but they are being used in such items as electrical wire core spools and dinnerware.

Inherent rigidity of basic styrene is a third factor that has prompted modifications. Normally, styrene has low tensile elongation and high tensile strength. It is vulnerable to sharp impact and very rapid loading. An improvement of its toughness properties was desirable.

Consideration of these three factors prompted the development of rubber-modified styrene. As may be seen in Table 1 rubber-modified materials

Fig. 3 — Refrigerator door liner is vacuum-formed from extruded sheets of high-impact styrene at Panelyte Div. of St. Regis Paper Co.

have more than ten times the tensile elongation of general-purpose styrene. They have double the impact strength, but only about two-thirds of the tensile strength. These properties combine to give toughness and high impact which are so important in industrial work. Modification may be controlled to provide either medium or high-impact strength.

▶ Types and Applications

High-impact styrenes of the rubber-modified type are used extensively by the refrigeration industry. The inner shell lining in the doors of most refrigerators produced today is made of high-impact styrene, either injection molded or formed from sheet, Fig. 3. Before the development of modified styrene, door liners were made of phenolic impregnated paperboard. As refrigeration manufacturers demand from their materials at least a 10-year use-life, the application of styrene here is a good example of its performance over long periods of time.

Other industrial applications which utilize the strength properties of high-impact styrene are: air conditioning grills which take advantage of the plastic's wide range of dimensional stability, Fig. 4; food packages which make use of its nontoxic property; and TV bezels which make use of both its toughness and dimensional stability. A major market for high-impact styrene is in toys where its resistance to breakage is an important property.

At the same time that modified styrene plastics were developed, it was realized that styrene processed in a certain way exhibits characteristic orientation. This is especially true of rubber-modified polymers.

When styrene is injection molded into a cavity, the material begins to chill on contacting the relatively cool cavity walls. The farther it is from the gate, the cooler the material becomes. The styrene on the surface begins to build up layers, so that the fastest moving material is in the hot center, while the material at the walls is being stretched and pulled along with it. The effect at the cavity wall surface is a pushing or pulling of the material in one direction. This orients the molecules undirectionally in the direction of flow.

In a large cavity, such as a 5-in. long bar, ½ by ½-in. in section, this effect is minimized, Fig. 2. In a very thin piece, such as a 5-in. long bar, ⅛ by ½-in. in section, this is accentuated. The thinner the wall section, therefore, the greater the orientation. The effect of this orientation is to produce high strength transverse to flow, but low strength parallel to flow. This is noticeable especially in thin wall containers of 0.015-in. wall section. In such moldings, a sudden blow may induce fracture parallel to flow.

This orientation is, in effect, a highly strained condition of the plastic. Annealing of thin wall moldings of about 0.020-in. in thickness has no effect, as the molecules are too rigidly aligned for

Table 1—Physical Properties of Styrene Plastics

Properties	General-Purpose Styrene	High-Heat, General-Purpose Styrene	High-Impact Styrene	Styrene Acrylonitrile
Mechanical				
Tensile strength, psi	6500 to 8000	8500 to 9500	3500 to 4500	7000 to 12,000
Elongation at break, per cent	1.8 to 2.4	1.0 to 2.0	20 to 30	1.5 to 2.5
Modulus of elasticity in tension, 1000 psi	400 to 500	500 to 600	400 to 500	300 to 560
Hardness, Rockwell	M70 to 80	M76 to 80	M46 to 55	M65 to 90
Flexural strength, psi	9000 to 13,000	13,000 to 15,000	4800 to 5300*	10,000 to 17,000
Deflection at break, in.	0.15 to 0.35	———	more than 0.20 (yield)	———
Impact strength, Izod, ft-lb per in. of notch				
½ by ½-in., notched	0.25 to 0.35	0.25 to 0.45	0.70 to 0.80	0.25 to 0.45
½ by ⅛-in., gate end notched	0.60 to 0.70	———	2.8 to 3.3	———
½ by ⅛-in., dead end notched	0.30 to 0.40	———	1.0 to 1.3	———
Machinability	Average	Average	Good	Average
Thermal				
Thermal expansion, 0.00001-in./in./deg C	6 to 8	6 to 8	7 to 8	6 to 8
Heat distortion, deg F at 264 psi	183 to 191	198 to 204	166 to 176	190 to 198
Deformation under load, per cent				
at 4000 psi at 50 C	0.8 to 1.0	0.6 to 0.8	Not applicable	———
at 2000 psi at 50 C	———	———	1.5 to 2.0	0.4 to 1.5
Optical				
Light transmission (0.050-in. thick), per cent	88 to 90	88 to 90	Not applicable	———
Color possibilities	Unlimited	Unlimited	Translucents, Opaques	Translucents, Opaques
Physical				
Specific gravity	1.04 to 1.06	1.04 to 1.06	1.05 to 1.08	1.05 to 1.11
Moisture absorption, per cent	0.03 to 0.04	0.03 to 0.05	0.07 to 0.08	0.05 to 0.08
Burning rate (0.050-in. thick), in./minute	1	1	1	1
Electrical				
Dissipation factor, 1,000,000 cycles	0.0001 to 0.0005	0.0001 to 0.0002	0.0009 to 0.0010	0.0003 to 0.0005
Dielectric constant, 1,000,000 cycles	2.45 to 2.65	2.4 to 2.6	2.55 to 2.70	2.45 to 3.1
Dielectric strength (⅛-in. thick), v/mil	more than 400	more than 400	more than 400	more than 400
Volume resistivity, ohm/cm	10^{19} to 10^{20}	more than 10^{14}	more than 10^{13}	more than 10^{13}

*At 0.2-in. deflection

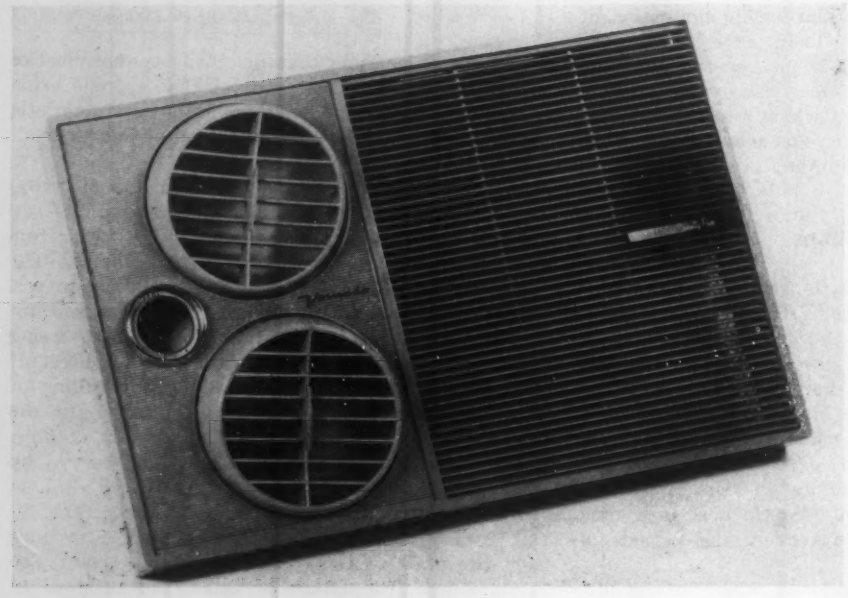

Fig. 4—Left—High-impact styrene is the material in this grille on the Vornado room air conditioner.

readjustment to a random relationship.

Because extruded sheets are not highly oriented, they exhibit more strength in the direction of extrusion than molded articles exhibit in the direction of flow. Extruded sheets may be vacuum formed into male or female molds by application of heat and atmospheric pressure. Large parts which otherwise would require large molds and expensive molding equipment are formed easily and inexpensively. Because of this low mold investment cost and the adaptability of the styrene sheet to short draw depths, a large percentage of the refrigerator inner shell liner doors are now being vacuum formed. The high-impact styrene product used in these extruded sheets is somewhat cloudy due to the inclusion of the rubber component.

Much has been done, and work is continuing, to improve optical clarity, but the present products are highly suitable for most applications. General-purpose styrene is crystal clear but too brittle to be used in sheet form. Because of its low tensile elongation, it cannot be drawn deeply.

A further refinement of this orientation effect, by the Plax Corp., Hartford, Conn., has been used to prepare a general-purpose styrene sheet with exceptional strength properties. This sheet is oriented biaxially, having been pulled in both directions simultaneously during manufacture to obtain uniform strength. It may be formed into much deeper draws than normally possible because of the increased strength in both the transverse and machine direction. It is used for transparent packages, container lids, venetian blinds, signs, lighting panels and many other applications where high strength is desirable.

Volume and variety of industrial consumption of styrene plastics have revealed the need for better chemical resistance. General-purpose and high-impact type styrenes are resistant to a wide

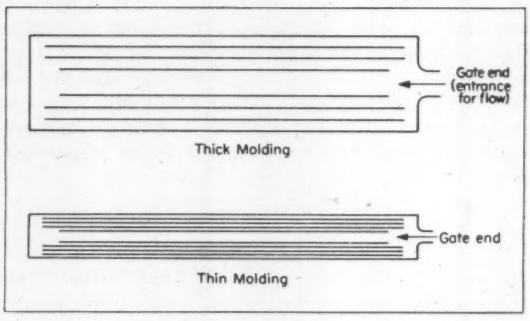

Fig. 5—Extent of styrene crystal orientation in thin and thick-walled products. In these diagrams, the closer the lines, the greater the orientation parallel to flow.

range of weak acids and alkalies, but they are attacked by essential oils, certain lubricating oils and strong acids. Acrylonitrile, incorporated with styrene during polymerization, increases chemical resistance measurably. Simultaneously, a higher heat distortion temperature (195 F) and impact strength are obtained. A slight transparent yellow color is typical of these products as compared to the colorless transparency of general-purpose styrene. Further research soon may remove this color.

Styrene-acrylonitrile molding materials are used in drinking tumblers because of their strength; in oil cups because of their chemical resistance; and in fan blades because of their good cold flow properties and low deformation under load characteristics. Styrene-acrylonitrile may itself be combined with butadiene to provide a high-impact type material with excellent chemical resistance. It is used in such items as pump parts, gaskets and lawnmower wheels.

Formulas and charts for calculating

Deflection of Circular Rings

loaded normal to plane of curvature

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DEFORMATION characteristics of circular rings loaded normal to the plane of curvature often form an important problem in design. Analyses of this problem are invariably based on the strain-energy method. Unfortunately this method is rather restricted in scope since the results it yields pertain to only one point in the ring. If design considerations require information at a number of points, the designer is faced with a considerable volume of repetitive work at every point involved. In addition to this laborious process, data on other forms of deformation, such as slope and angle of twist, are often needed. Presented here is a general form of solution developed through the solution of an ordinary differential equation of the third order.

General Deflection Equation: Derivation of Equations 1 and 2, which govern the deformation of curved bars and rings loaded normal to the plane of curvature, is accomplished by expressing curvature and twist as functions of displacement and angular rotation. This approach is similar to that adopted in establishing the deflection equation for curved bars loaded in plane. There exists, however, an important difference in that the former flexure is accompanied by torsion. This has a definite effect on the deformation characteristics.

The differential equations referred to previously are

$$\frac{M_\theta}{EI} = \frac{\beta}{R} - \frac{1}{R^2}\frac{d^2\omega}{d\theta^2} \qquad (1)$$

$$\frac{T_\theta}{KG} = \frac{1}{R}\frac{d\beta}{d\theta} + \frac{1}{R^2}\frac{d\omega}{d\theta} \qquad (2)$$

Differentiating Equation 1 with respect to θ and combining with Equation 2 eliminate β and the

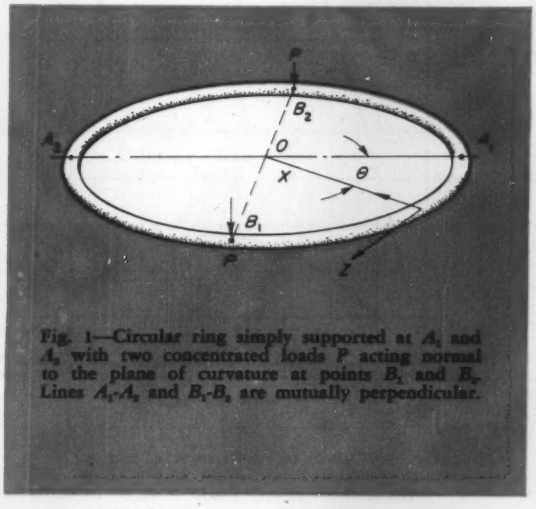


Fig. 1—Circular ring simply supported at A_1 and A_2 with two concentrated loads P acting normal to the plane of curvature at points B_1 and B_2. Lines A_1-A_2 and B_1-B_2 are mutually perpendicular.

Nomenclature

c = Radius of ring cross section, in.
E = Modulus of elasticity, psi
G = Modulus of rigidity, psi
I = Moment of inertia about the x-axis of the ring cross section, in.^{4}
I/c = Section modulus, in.^{3}
K = Form factor relevant to torsion which depends on shape of cross section, in.^{4}
M_θ = Bending moment about x-axis at angle θ, lb-in.
P = Concentrated load, lb
R = Radius of ring, in.
s = Slope, rad
$= (1/R)(d\omega/d\theta)$
T_θ = Torsion about z-axis at angle θ, lb-in.
β = Angle of twist, rad
θ = Angle with respect to line A_1-A_2 in Fig. 1 taken in a clockwise direction, deg or rad
σ = Bending stress, psi
$= M_\theta c/I$
τ = Torsional shear stress for circular cross section, psi
$= T_\theta c/K$
ϕ = Constant
$= EI/(KG)$
ω = Deflection, in.

following general deflection equation is obtained.

$$\frac{d^3\omega}{d\theta^3} + \frac{d\omega}{d\theta} = -R^2\left(\frac{1}{EI}\frac{dM_\theta}{d\theta} - \frac{T_\theta}{KG}\right) \qquad (3)$$

This is an ordinary differential equation of the third order, and its solution consists of three arbitrary constants of integration. These constants must be determined from the known conditions at three points on the ring.

With an expression for the deflection of the ring available, the slope at any point can now be determined. Similarly, by substituting the second derivative of the deflection in Equation 1, the designer can calculate the angle of twist at any point. This method of analysis will now be illustrated with two examples.

Deflection by Concentrated Load: Consider the deformation characteristics of the ring shown in Fig. 1 which is simply supported at A_1 and A_2. The line joining A_1 and A_2 is a diameter. The concentrated loads P acting normal to the plane of curvature are applied at points B_1 and B_2. The line joining B_1 and B_2 is a diameter. Lines A_1-A_2 and B_1-B_2 are mutually perpendicular.

From symmetry of loading and form of support, it is clear that the reactive torsion at A_1 and A_2 is zero, and the value of the bending moment and torsion at any angle θ is therefore

$$M_\theta = \frac{PR}{2}(\cos\theta - \sin\theta)$$

$$T_\theta = \frac{PR}{2}(\sin\theta + \cos\theta - 1)$$

$$\frac{dM_\theta}{d\theta} = -\frac{PR}{2}(\sin\theta + \cos\theta)$$

Substituting for T_θ and $dM_\theta/d\theta$ in Equation 3

$$\frac{d^3\omega}{d\theta^3} + \frac{d\omega}{d\theta} = \alpha_c(\sin\theta + \cos\theta) + \gamma_c(\sin\theta + \cos\theta - 1) \qquad (4)$$

where $\alpha_c = PR^3/2EI$ and $\gamma_c = PR^3/KG$. The solution of Equation 4 gives the general expression for the deflection at any point, or

$$\omega = \frac{PR^3}{4EI}(a_1 + \phi\, b_1) \qquad (5)$$

where

$$a_1 = \left(1 - \frac{\pi}{2}\right)\left(1 - \cos\theta\right) + (1 - \theta)\sin\theta - \theta\cos\theta$$

$$b_1 = 3 - \frac{\pi}{2} - 2\theta + \left(\frac{\pi}{2} - 3 - \theta\right)\cos\theta + (3 - \theta)\sin\theta$$

Values of a_1 and b_1 can be obtained from the curves in Fig. 2. The slope s at any point can now be obtained by differentiating Equation 5, or

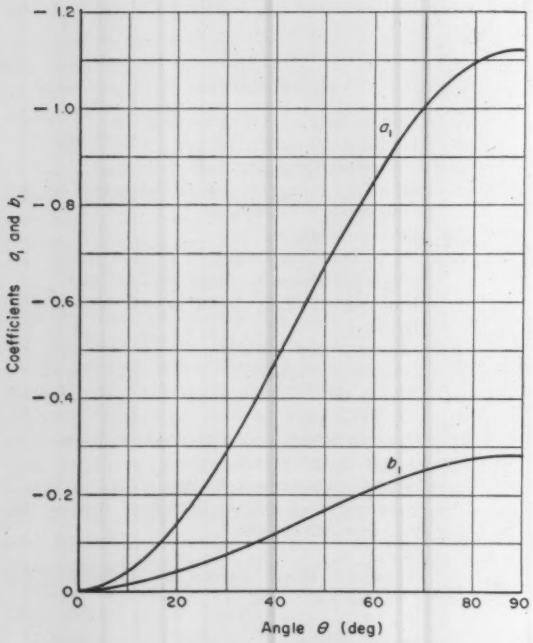


Fig. 2—Curves of coefficients a_1 and b_1 for calculating ring deflection with a concentrated symmetrical load.

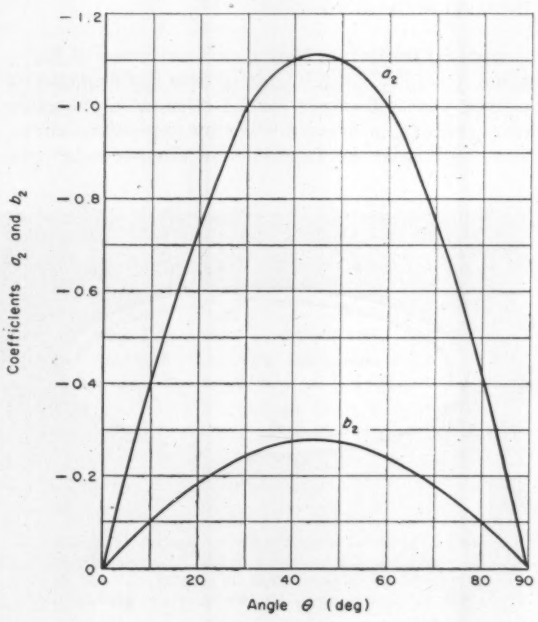


Fig. 3—Curves of coefficients a_2 and b_2 for calculating ring slope with a concentrated symmetrical load.

$$s = \frac{1}{R}\frac{d\omega}{d\theta} = \frac{PR^2}{4EI}(a_2 + \theta\, b_2) \qquad (6)$$

where

$$a_2 = \left(\theta - \frac{\pi}{2}\right)\sin\theta - \theta\cos\theta$$

$$b_2 = \left(2 - \frac{\pi}{2}\right)\sin\theta + 2(\cos\theta - 1) + \theta(\sin\theta - \cos\theta)$$

Values of a_2 and b_2 can be obtained from the curves in Fig. 3.

To obtain the angle of twist at any point, the second derivative of Equation 5 and M_θ are substituted into Equation 1, thus

$$\beta = \frac{PR^2}{4EI}(1 + \phi)a \qquad (7)$$

where

$$a = \left(\theta - \frac{\pi}{2} + 1\right)\cos\theta + (\theta - 1)\sin\theta$$

Values of a are given by the curve in Fig. 4.

Information on deformation characteristics is now complete, and the maximum bending and torsional shear stresses can be calculated by using the bending-moment and torsion-distribution curves in Fig. 5.

Deflection by Uniformly Distributed Load: In this discussion assume that the ring in Fig. 1 is subjected to a uniformly distributed load. The process of solution is similar to the concentrated-load case and is summarized as follows

When the load is uniformly distributed,

$$M_\theta = qR^2(1 - \pi\sin\theta)$$

$$T_\theta = qR^2[\theta + \pi(\cos\theta - 1)]$$

$$\frac{dM_\theta}{d\theta} = -\pi qR^2\cos\theta$$

Substituting for T_θ and $dM_\theta/d\theta$ in Equation 3

$$\frac{d^3\omega}{d\theta^3} + \frac{d\omega}{d\theta} = a_u\pi\cos\theta - \gamma_u[\theta + \pi(\cos\theta - 1)]$$

where $a_u = qR^4/EI$ and $\gamma_u = qR^4/KG$. The solution of this equation gives the general expression for the deflection at any point as

$$\omega = \frac{\pi qR^4}{2EI}(a_3 + \phi\, b_3) \qquad (8)$$

where

$$a_3 = \sin\theta + \left(\frac{\pi}{2} - \theta\right)\cos\theta - \frac{\pi}{2}$$

$$b_3 = \theta(2 + \cos\theta) - 3\sin\theta + \left(1 - \frac{\pi}{2}\right)(\cos\theta - 1) - \frac{\theta^2}{\pi}$$

Values of a_3 and b_3 are given by the curves in Fig. 6.

The equation for calculating slope is

$$s = \frac{1}{R}\frac{d\omega}{d\theta} = \frac{\pi qR^3}{2EI}(a_4 + \phi\, b_4) \qquad (9)$$

where

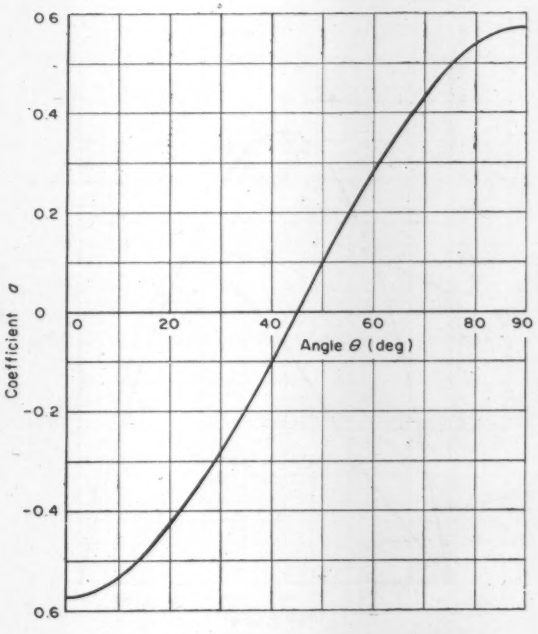


Fig. 4—Curve of coefficient a for calculating ring angle of twist with a concentrated symmetrical load.

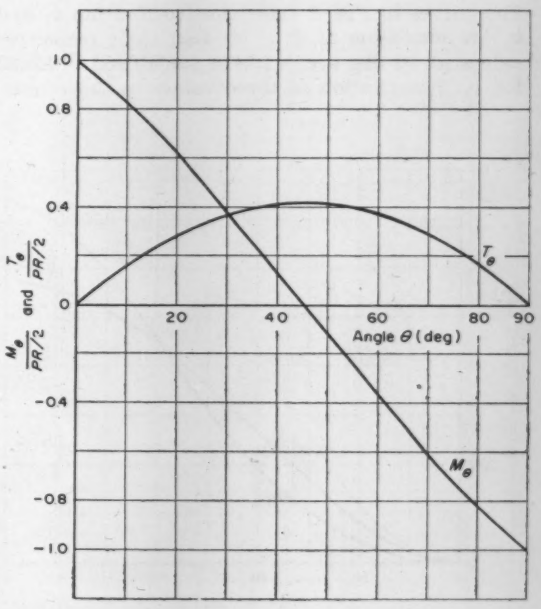


Fig. 5—Ring torsion and bending moment distribution curves for a concentrated symmetrical load.

$$a_4 = \left(\theta - \frac{\pi}{2} \right) \sin \theta$$

$$b_4 = \left(\frac{\pi}{2} - 1 - \theta \right) \sin \theta - 2 \left(\cos \theta - 1 + \frac{\theta}{\pi} \right)$$

The angle of twist at any point is

$$\beta = \frac{qR^3}{EI} (a_5 + \phi b_5) \qquad (10)$$

where

$$a_5 = 1 - \frac{\pi}{2} \sin \theta + \frac{\pi^2}{2} \left(\frac{\theta}{\pi} - \frac{1}{2} \right) \cos \theta$$

$$b_5 = \frac{\pi}{2} \sin \theta + \frac{\pi^2}{2} \left(\frac{1}{2} - \frac{1}{\pi} - \frac{\theta}{\pi} \right) \cos \theta - 1$$

Values for a_4, b_4, a_5 and b_5 are given by the curves in Fig. 7 and 8, respectively. The bending-moment and torsion-distribution curves are shown in Fig. 9.

Example 1: To illustrate the application of the previous analysis, consider the case of a circular ring of uniform cross section supported and loaded as shown in Fig. 1. Assume that the concentrated load $P = 250$ lb, ring radius $R = 10$ in., the material is steel with $E = 30 \times 10^6$ psi and $G = 12 \times 10^6$ psi, and the ring cross section is circular.

Suppose the diameter of the cross section is 1 in.; then $I = \pi/64(1^4) = 0.0492$ in.^{4}, $K = 2I = 0.0984$ in.^{4}, and $\phi = EI/KG = 1.25$.

The deflection at any point is given by Equation 5 or $\omega = PR^3/4EI\ (a_1 + 1.25\, b_1)$.

Assume that the maximum deflection is required. The curves in Fig. 2 show that coefficients a_1 and b_1 are maximum at $\theta = 90$ deg; their respective values at 90 deg are -1.1416 for a_1 and -0.2832 for b_1. Substitution of these values in the expression for ω gives

$$\omega_{max} = \frac{250(10^3)[-1.1416 - 1.25(0.2832)]}{4(30)(10^6)(0.0492)} = -0.0635 \text{ in.}$$

The negative sign indicates that the deflection is downward.

With regard to the slope, the coefficients a_2 and b_2 are obtained from Fig. 3 and are both zero at $\theta = 90$ deg. Thus, the slope there is zero.

The maximum slope occurs at $\theta = 45$ deg. This is apparent from Fig. 3, and the corresponding values of a_2 and b_2 are -1.111 and -0.2825, respectively.

Substituting the proper values in the expression for the slope given by Equation 6 shows that

$$s = \frac{250(10^2)[-1.111 - 0.282(1.25)]}{4(30)(10^6)(0.0492)} = -0.0062 \text{ rad}$$

The angular rotation at any point is given by Equation 7, or $\beta = (PR^2/4EI)\ (1 + 1.25)a$. The coefficient a at $\theta = 90$ deg is obtained from the curve in Fig. 4, and this value of a is 0.5707. Thus

$$\beta = \frac{250(10^2)(2.25)(0.5707)}{4(30)(10^6)(0.0492)} = 0.00546 \text{ rad}$$

The positive sign indicates a counterclockwise rotation when viewed in the direction of the z-axis.

Since the optimum deformation characteristics of the ring have been established, evaluation of the maximum bending stress σ_{max} and torsional shear stress τ_{max} is necessary for the complete solution of the problem.

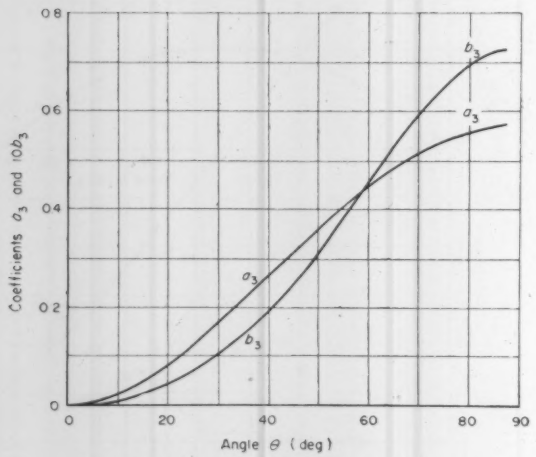


Fig. 6—Curves of coefficients a_3 and b_3 for calculating ring deflection with a uniformly distributed load.

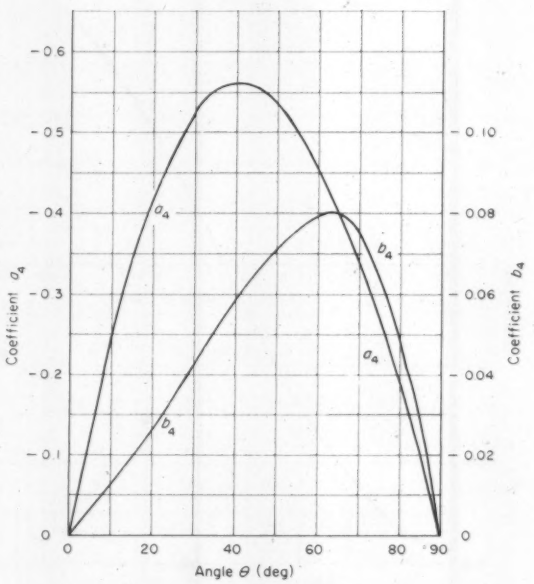


Fig. 7—Curves of coefficients a_4 and b_4 for calculating ring slope with a uniformly distributed load.

From the bending and torsion distribution curves in Fig. 5, the maximum bending moment $M_{max} = \pm 1.0\ (P/2)\ R$ at $\theta = 0$ and $\theta = 90$ deg, and the maximum torsion $T_{max} = 0.414\ (P/2)\ R$ at $\theta = 45$ deg.
Thus

$$\sigma_{max} = \pm \frac{M_{max}\, c}{I} = \pm \frac{1(250)(10)(0.5)}{2(0.0492)}$$

$$= \pm 12{,}680 \text{ psi}$$

$$\tau_{max} = \frac{T_{max}\, c}{K} = \frac{0.414(250)(10)(0.5)}{2(0.0984)}$$

$$= 2650 \text{ psi}$$

Example 2: Assume that the ring just considered is subjected to an equivalent uniformly distributed load q lb per in. Thus $q = 500/2\pi R = 7.95$ lb per in.

The deflection at any point is given by Equation 8, and substituting 1.25 for ϕ gives

$$\omega = \frac{\pi q R^4}{2EI}\ (a_3 + 1.25\, b_3)$$

It is apparent from Fig. 6 that coefficients a_3 and b_3 are maximum at $a_3 = -0.5707$ and $b_3 = -0.073$. Thus

$$\omega_{max} = \frac{\pi(7.95)(10^4)[-0.5707 - 1.25(0.073)]}{2(30)(10^6)(0.0492)}$$

$$= -0.056 \text{ in.}$$

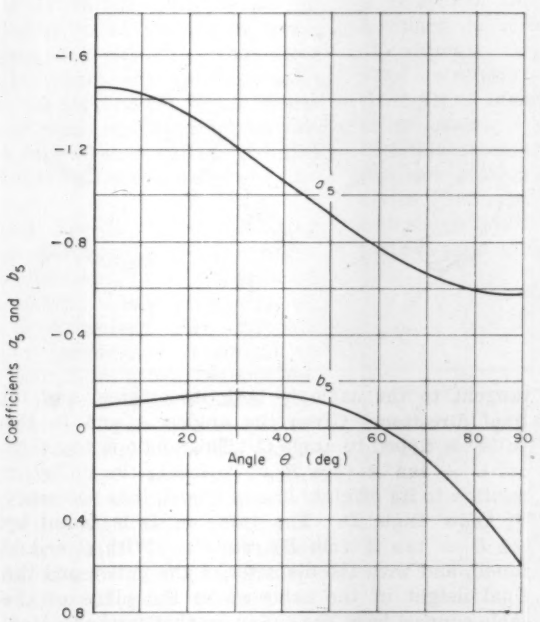


Fig. 8—Curves of coefficients a_5 and b_5 for calculating ring angle of twist with uniformly distributed load.

The negative sign indicates a downward deflection and compares with a maximum deflection of -0.0635 in. in Example 1.

The slope at $\theta = 90$ deg is obviously zero since $a_4 = b_4 = 0$, which is apparent from Fig. 7 and 8. However, the maximum slope occurs at $\theta = 45$ deg where $a_4 = -0.555$ and $b_4 = -0.0658$. Applying Equation 9, the maximum value for slope can be calculated, or

$$s_{max} = \frac{\pi(7.95)(10^3)[-0.555 - 1.25(0.0658)]}{2(30)(10^6)(0.0492)}$$

$$= -0.00538 \text{ rad}$$

This value compares with a slope of -0.0062 rad in Example 1. The angle of rotation at any point is given by Equation 10, and for $\phi = 1.25$

$$\beta = \frac{qR^3}{EI}\ (a_5 + 1.25\, b_5)$$

For the particular location $\theta = 90$ deg values of a_5 and b_5 obtained from Fig. 7 and 8 are, respectively, -0.5707 and $+0.5707$.

It is of interest to note that for $\phi = 1.0$ the angular rotation at $\theta = 90$ deg is zero. A requirement that no rotation occur at $\theta = 90$ deg implies

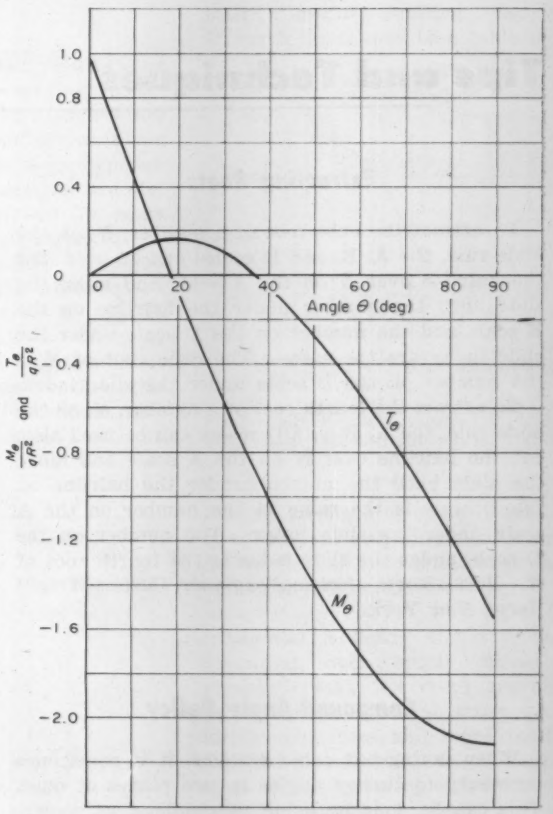


Fig. 9—Ring bending-moment and torsion-distribution curves with a uniformly distributed load.

that the flexural and torsional rigidities EI and KG, respectively, must be of the same magnitude.

To return to the present example, substituting the previously found values for a_5 and b_5,

$$\beta = \frac{7.95(10^3)[-0.5707 + 1.25(0.5707)]}{30(10^6)(0.0492)}$$

$$= 0.00077 \text{ rad}$$

The positive sign indicates a counterclockwise rotation when viewed in the direction of the z-axis.

The maximum angular rotation occurs at $\theta = 0$ where, from Fig. 7 and 8, $a_5 = -1.467$ and $b_5 = -0.1034$. Thus

$$\beta = \frac{7.95(10^3)[-1.467 - 1.25(0.1034)]}{30(10^6)(0.0492)}$$

$$= -0.0086 \text{ rad}$$

The negative sign indicates a clockwise rotation when viewed in the direction of the z-axis.

The maximum bending moment and torsion are obtained from Fig. 9, and the relevant stresses are calculated in the same manner as done in Example 1.

Example 3: If the two loading cases discussed in Examples 1 and 2 act simultaneously, the effective deflection, slope and rotation at any point in the ring may be obtained by superposition. Thus the overall deflection, slope and angular rotation at $\theta = 90$ deg are respectively, $\omega = -0.0635 - 0.056 = -0.1195$ in., $s = 0$, and $\beta = 0.00546 + 0.00077 = 0.00623$ rad.

Summary Remarks: It should be noted that the expressions for deflection, slope and angular rotation are made up of two distinct terms, characterized throughout the article by the terms a and b. These terms have a clearly defined meaning. Factor a indicates the contribution of flexure towards the general result, whether it be deflection, slope or rotation. In a similar sense factor b indicates the effect of torsion. This is a fortunate division, because it provides the designer, at an early stage, with the means of establishing optimum values for the flexural and torsional rigidities to fit specified deformation characteristics. The effectiveness of the curves presented in this article lie, therefore, in the preliminary rather than the final design stage.

The torsional rigidity merits close scrutiny since for open cross sections it is often a mere fraction of the flexural rigidity. Thus, even if the value of b is small compared with a, the deflection, slope, and angular rotation due to torsion may well exceed that due to flexure and result in unduly large deformations.

Tips and Techniques

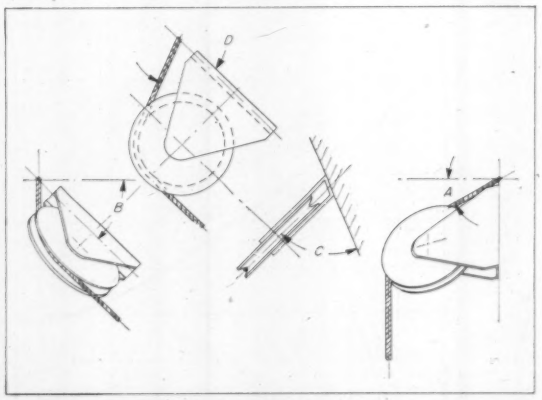
Extracting Roots

To extract the cube root of a number, N, on the slide rule, the A, B, and D scales can be used. Set the hairline over N on the A scale and move the slide until the number under the hairline on the B scale and the number on the D scale under the slide index are the same. The cube root of N is the number on the D scale under the slide index.

To extract the fourth root of a number, N, on the slide rule, the A, B, and D scales can be used also. Set the hairline over N on the A scale and move the slide until the number under the hairline on the B scale is the same as the number on the A scale under the slide index. The number on the D scale under the slide index is the fourth root of N.—JESSE ROTH, *electrical engineer, Curtiss-Wright Corp., New York.*

Compound-Angle Pulley

When laying out cable systems, it is sometimes necessary to change angles in two planes at once. This can be done by using two pulleys, as shown, but by use of a few simple equations, one pulley can be located, tipped, and rotated so that it is



tangent to the cable in both its original and its final direction. Given the angles A and B, the pulley is tipped to angle C. This angle is found by $\cot C = \tan A \ (\cos B)$. To locate the pulley in relation to its original line of travel, it is necessary to know angle D. The value of D is found by $\cot D = \tan A \ (\sin B) \ (\sin C)$. With C and D found, and with the diameter of the pulley and the final height of the cable above the plane of the cable-support base, the pulley bracket can be located. —JOSEPH F. LENZEN, *reactor engineering division, Argonne National Laboratory, Lemont, Ill.*

Selection and application of

Roller-Chain Drives

By R. A. SCHAKEL and C. O. SUNDBERG
Diamond Chain Co.
Indianapolis, Ind.

Roller-chain drives may be selected on the basis of design life needed for specific applications by outlining chain-drive requirements in terms of horsepower, sprocket size, and sprocket speed

ROLLER chains are characterized by flat link plates, relatively short pitch, free-turning roller contact with sprocket teeth, and precision mating parts. They are available in multiple strand widths up to 12 strands or more. Criteria for selecting the most suitable chain and sprocket combinations for specific requirements include chain and sprocket speeds, chain fatigue strength, roller-bushing impact strength, and wear life.

Shaft Speed: In transmitting power between rotating shafts, roller chains frequently operate at high speeds. Pin galling is an effect of extremely high sprocket angular speeds and is similar to that found on other bearing devices. In roller chains, such galling seems to be independent of lubrication as long as flooded conditions are used, and may occur even with minor chain loading if speeds are high enough. Preliminary test results show that minor galling occurs when chains are operated over 25-tooth sprockets at speeds shown in Fig. 1.

Maximum pitch of the chain may be determined initially by shaft speeds. Generally, this applies to drives close to the power source. If shaft speeds are too high for a given pitch chain, a smaller pitch chain usually will accommodate them.

Fatigue Strength: Fatigue strength of load-carrying members is an important consideration for selection of chain drives. Since fatigue phenomenon is recognized, it is seldom that designs are determined deliberately on the basis of ultimate tensile strength or yield strength alone. Fatigue strength of standard transmission roller chains is shown in Fig. 2. Ultimate strength of the chain in this case is 3700 lb. At 10 million cycles, the load has reached the endurance limit of the chain and further application of load will not cause fracture.

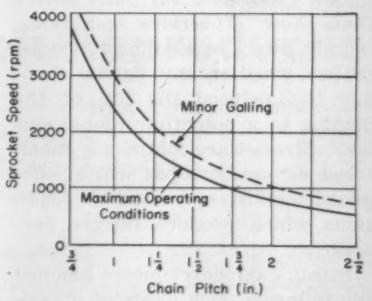


Fig. 1 — Maximum allowable sprocket speeds with 25-tooth sprockets due to pin galling on forced flood lubricated drives

Chain fatigue strength values are readily converted to horsepower-speed relationships for a given sprocket size. When plotted graphically, useful limiting fatigue strength limits may be established.

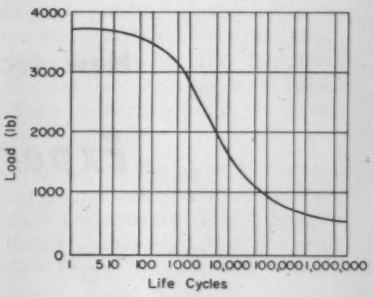


Fig.2—Fatigue characteristics of ½-in. pitch chain. Ultimate strength is 3700 lb.

Fatigue strength of chain is usually of concern only in slower-speed drives such as transmission, drum, and rotary table drives.

Chordal Action: Chain drives operating over small diameter sprockets with few teeth are not as smooth in action as those with larger diameters and more teeth. Chordal rise and fall in the tight span of an operating drive varies with the number of teeth in the sprockets. Smaller sprockets impose greater abuse on chain rollers

and bushings which are engaging the sprocket teeth. Since most drives can be designed with larger sprockets, their use is warranted not only because less abusive roller-bushing impact conditions are achieved, but because chain loading is lessened and smooth drive action obtained.

Roller-Bushing Impact Life: Although failure of a few rollers and bushings in an operating chain drive will not ordinarily make the drive inoperative, it does cause rough operation which might impose sufficient additional chain loading to result in shortened service life. There is some correlation between calculated impact energy and roller breakage. For the same size sprocket, impact energy decreases with a decrease in sprocket speed and, for constant linear chain speed, impact energy decreases as number of teeth increases. Coolant viscosity plays an important part on roller impact failure, and coolant flow rate at point of impact is of considerable importance. Also, tension may have a direct effect on impact energy and roller breakage.

Although no rigorous analysis of the mechanics of roller-sprocket impact has been made to explain the excellent correlation between operating drive conditions and roller-bushing impact life, reasoning suggests that the correlation is valid. By means of minimum-life lines of appropriate charts, roller-bushing impact survival can be predicted with sufficient reliability to permit chain drive selection. When this information is transposed into customary horsepower-speed factors and combined with fatigue strength data, relationship between link plate fatigue and roller-bushing impact life is obtained.

Wear Life: Roller chains are constructed to provide good wear resistance in operating drives. Rolling contact between sprocket teeth and chain rollers minimizes sprocket wear. Pins and bushings are usually case-hardened to produce hard, long wearing, bearing surfaces in chain joints. Where lubrication is adequate or ultimate tensile strength is of more importance than long life, pins are medium carbon heat-treated steel. Test results suggest that wear rate is greater at slower speed and decreases as speed increases. This may be due to formation of a supporting wedge of lubricant between pins and bushings in chain joints at the higher speeds. At chain speeds in excess of 6000 fpm, wear is less than 1 per cent for 10,000 hr of operation.

Pump lubrication on drives at points where the chain enters the sprockets serves to cushion the impact between chain rollers and sprocket teeth. It also provides an inexhaustible supply of lubricant to minimize wear, and cools the chain sufficiently to keep the coefficient of friction in the chain joints low. Chain fatigue life and roller-bushing impact life can be predicted reliably on this basis.

From a paper entitled "Proven Concepts in Oil Field Roller Chain Drive Selection," presented at the ASME Petroleum Mechanical Engineering Conference in Tulsa, Okla., September, 1957.

New techniques of

Experimental Stress Analysis

By B. R. ANDERSON
Flight Propulsion Laboratory Dept.
General Electric Co.
Evendale, Ohio

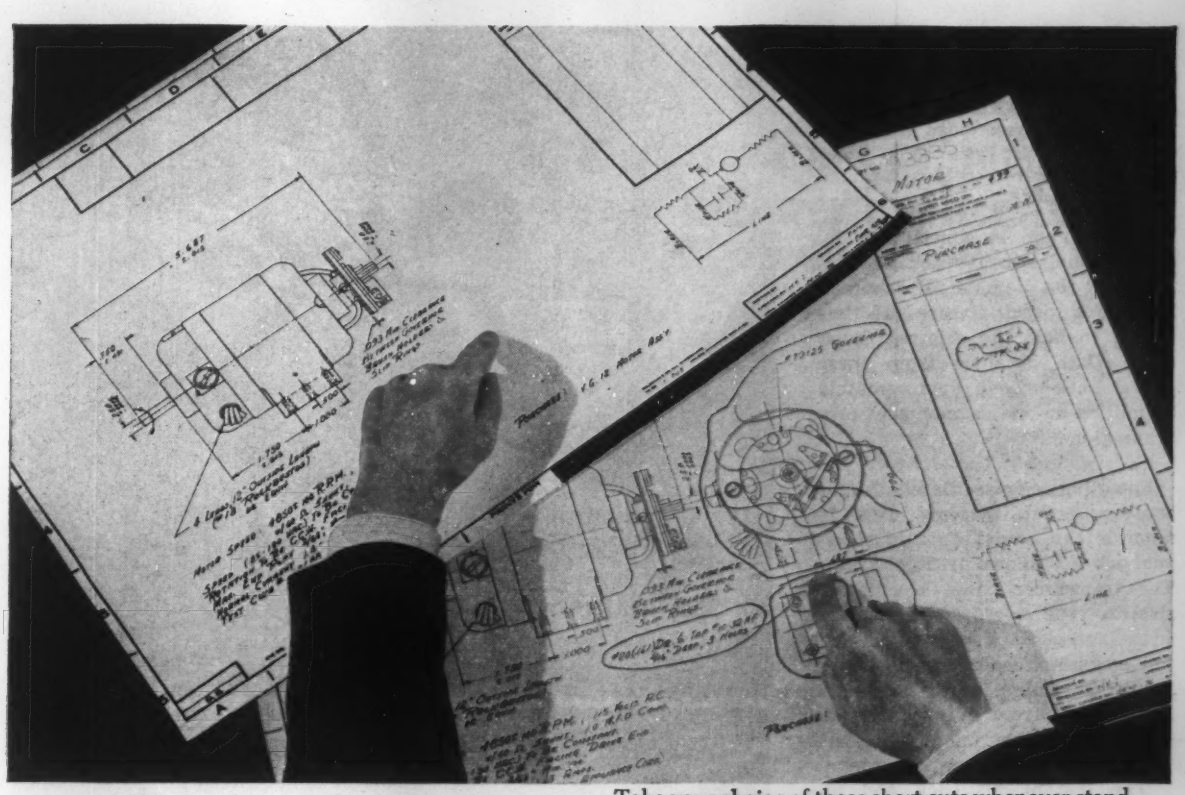
New strain gages and improved data-recording systems meet present day critical needs of experimental stress analysis

NEW and modified techniques of experimental stress analysis are the results of strain gage development and improved data-recording machines. Formerly, vibratory stress measurements on rotor blades of jet engines, for example, were made while the engine operated in a test cell. Now, such data must be obtained on prototype engines during initial testing, not on components in service.

Test conditions, far more severe than those of service operations, require direct measurements to establish whether any partial damage has reduced the life of the blading to a potentially dangerous level. Stresses are continually monitored on oscilloscopes which safeguard against operation at conditions which produce fatigue failures.

Strain gage development has met the following new needs of experimental stress analysis:

1. Number of gages and lead-in wires that could be attached to blades have been increased by as much as 200.
2. Gages have been designed to operate at centrifugal forces of 30,000 g and at temperatures to 1500 F.
3. A flexible, multichannel monitoring and magnetic-tape data-recording system has been developed to observe and record data simultaneously from dc to 30,000 cps.
4. Circuitry has been improved to transmit simultaneously more signals off the rotor with greater accuracy.
5. An efficient multichannel data-



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reduction system has been developed to analyze a tremendous number of recordings in a single test. In one instance, 17 miles of tape were recorded during a single test.

The new gage is constructed by hand-winding strain-sensitive wire, one-third the diameter of a human hair, on a special fixture and flattening to half the original diameter. Data obtained from these gages have saved approximately $2 million on one development program alone.

Recording Stress Data: Major components in systems used to monitor and record data in stress analysis are shown in Fig. 1, top. The transducer panel accepts resistance-type or self-generating transducers. It also provides output jacks for feeding signals to the amplifier which must raise the signal level from a few millivolts to one volt, the amount required by the magnetic-tape recorder.

The instant playback and unlimited analysis features of data recorded on magnetic tape, Fig. 1, bottom, offer a tremendous advantage in cases where test conditions can't be reproduced. Once data are on the tape, tests can be rerun for detailed study as many times as necessary. Tape playback speed can be reduced by as much as 20 to 1 so that rapid transients can be recorded on low-response oscillographs for precise study.

From "Producing Better Jet Engines Experimentally," in General Electric Review, *Vol.* 60, *No.* 5, *September,* 1957.

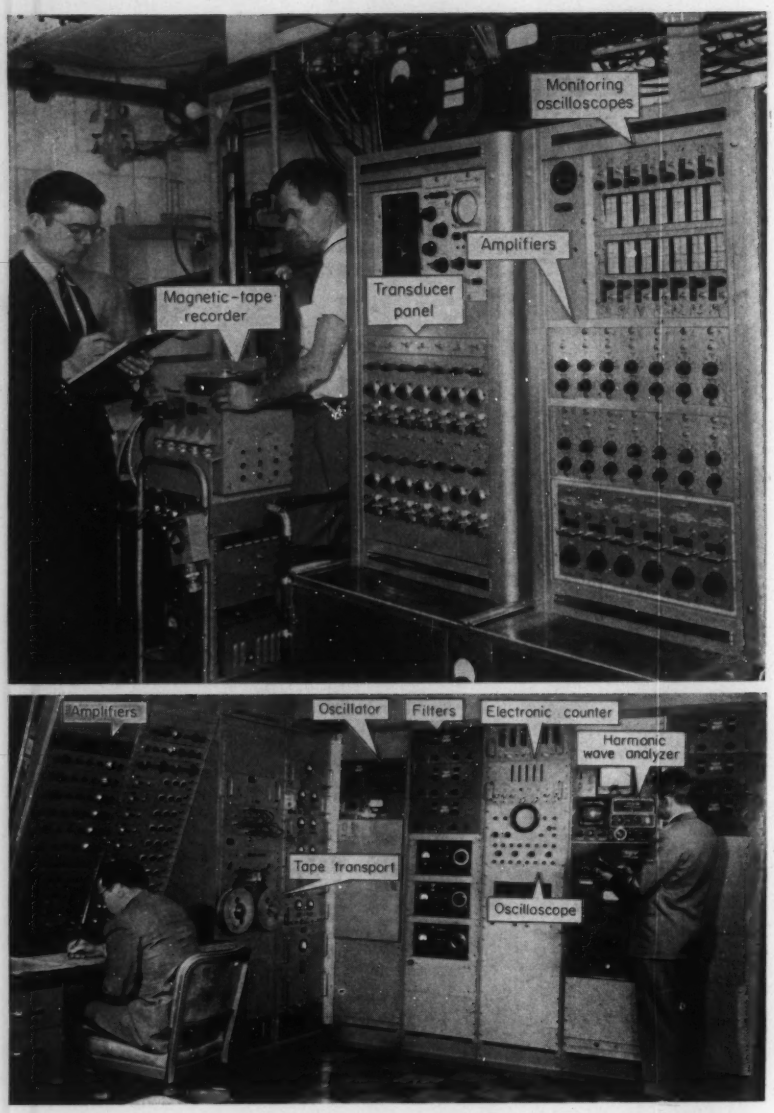


Fig. 1—Top—Instruments of recording system used in monitoring stress data input. Amplifier output feeds oscilloscopes, magnetic-tape recorder, and harmonic-wave analyzer. Bottom—Instant playback of data simplifies analysis of vibratory stresses. Significant points of recording frequency, level, or phase can be analyzed in detail.

Safety in Design

When safety is taught through the medium of machine design, there will be less chance of overlooking the one critical application or misapplication that causes failure

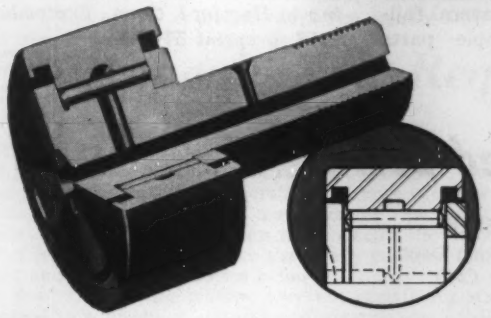
THE idea of a factor of safety is so emphasized in courses in strength of materials and machine design, that safe design is apt to be taken for granted. Unfortunately, the factor of safety is often used blindly as an alternative to careful consideration of various possibilities of failure. If this practice is followed, there will be a tendency to design machine members to suit only one or two possible applications and overlook the one misapplication which will cause failure.

Because of this, a definite attempt should be made to stress the need for safety in teaching machine design. Merely describing a complex machine and its safety requirements has little lasting effect on students. The idea has been proposed of introducing the subject of safety in courses in design of machine elements. In this way, it is possible to solve problems which illustrate both safety and design principles.

A project at Cornell University is responsible for obtaining material for machine design problems. Problems are suggested by insurance and other companies, and

BEARING TIPS by McGill

sealed CAMROL® bearings lock out contamination in critical cam follower applications

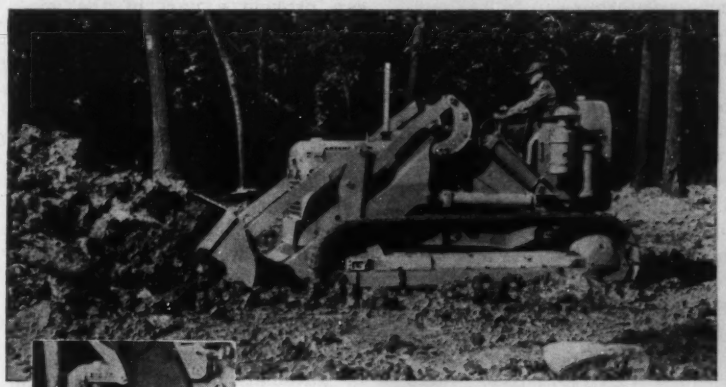


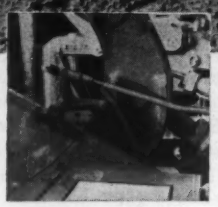
Now Sealed and Prelubricated

The new SCF series of the famous CAMROL cam follower completely seals out dirt, chips, moisture, etc. — an important advantage where the life of an ordinarily open mounted cam follower can be materially increased with adequate protection against contamination. Also the sealed bearing is pre-lubricated with provision made for easy re-lubrication, if desired, through either end of the stud.

Specially treated synthetic seals are contained in the outer race undercuts over the stud flange and roller retaining washer. For added protection, all external surfaces of the bearing are treated to provide a corrosion resistant, black ferrous oxide surface.

These same advantages are available in the SCYR sealed series Cam Yoke Roller (without stud). Specify CAMROL bearings with the built-in seals that preserve cam follower dependability in critical cam action, support or track roller application.





Built-in seals protect and preserve CAMROL® bearings from contamination in CATERPILLAR-built TRAXCAVATORS®

McGill SCF series sealed CAMROL bearings provide the cam action that positions the bucket of the No. 977 Traxcavator unit at the selected digging angle. Mounted on bell crank arms that are actuated by contact with a cam shoe on a hydraulic cylinder linkage, these bearings are operating in the open and exposed constantly to dust, dirt and moisture. External surfaces have a black ferrous-oxide finish to prevent corrosion. These sealed McGill cam followers eliminate the need for relubrication and maintenance after installation. Caterpillar uses other McGill bearings including twelve CYR series cam yoke roller bearings in the flywheel clutch.

378 sealed CAMROL® bearings guide engine blocks in INGERSOLL automatic milling machine

The sealed CAMROL bearings used in this machine, guide cylinder blocks during transfer through various milling, boring and drilling operations. The bearings, used in place of guide bars, eliminate surface scratching of the 200 to 300 pound blocks which are transferred at speeds up to 400 feet per minute. Blocks are processed at the rate of 95 per hour. Ingersoll reports freer movement, accuracy of positioning and materially longer bearing life due to the new design that seals metal chips out of the bearings.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

are organized for classroom presentation. They are analyzed for soundness of original design and safety features, and possibilities of misapplication. For example, a hook designed to carry a load colinear with the shank centerline was stressed at 29,150 psi under proper application. However, the hook was embedded in a wall so that the load was applied perpendicularly to the shank. In this case of misapplication, maximum stress under load was 142,000 psi, and failure occurred. This example is typical of problems suggested by companies in which several failures of obviously simple parts caused investigation of design and safety features and resultant design changes to incorporate safety.

From a paper entitled "The How of Safe Design," by H. H. Mabie, Prof. of Mechanical Engineering, Cornell University, Ithaca, N. Y., presented at the ASME Fall Meeting in Hartford, Conn., September, 1957, *preprint* 57-F-32.

Adjustable-Speed Drives

By A. T. BACHELER
Systems Control Engineering Dept.
Westinghouse Electric Corp.
Buffalo, N. Y.

This abstract describes basic features of the direct-current adjustable-voltage drive, and includes characteristics of the constant-speed shunt-wound motor and the compound-wound motor.

IN ITS simplest form, the adjustable-voltage dc drive consists of a dc shunt-wound motor excited at constant field and whose armature is energized from a separately excited constant-speed dc generator. Field excitation of the generator is adjusted to vary generator voltage and motor speed.

Motor Characteristics: The shunt-wound motor has essentially constant-speed characteristics and nearly constant torque capacity over the entire speed range. It is suitable for driving loads that must run at essentially the same speed setting regardless of load variation, and for operation in tandem with other shunt motors where speeds must follow each other closely or be synchronized.

Another method of operating a shunt motor is to vary its field strength at a fixed value of armature voltage, either at rated voltage or some lower voltage. When the motor field is weakened, its speed increases. Instead of providing constant-torque capability, however, it has essentially constant-horsepower capacity.

Compound-Wound Motors: Compound-wound motors have two sources of field excitation; a shunt or separately excited field, and a load current-excited field connected in series with the armature. Both fields are connected additively and, consequently, when load increases, net field strength increases and speed decreases.

Mechanical Drives: Drives geared or coupled to the driven shaft frequently must be mounted well above floor level. A support for such a direct drive must be quite rigid in order to maintain proper alignment under all conditions of loading. A solution that is usually economical uses a floor-mounted gearmotor solidly anchored on a slide base and connected to the driven shaft by chain and sprockets. This arrangement is tolerant of misalignment. The chain drive can provide a part of the speed reduction thereby reducing gear ratio and the size and cost of the gear box as well.

Generator Characteristics: The separately excited generator used with adjustable-voltage drives provides most of the speed range of the drive. Generator-output voltage is adjustable by varying field-excitation current and voltage is only slightly affected by load current drawn by the motors. The generator can be controlled manually or automatically by a voltage or speed regulator.

From a paper entitled "Modern Adjustable-Speed Drives for Textile Machinery," presented at the ASME Fall Meeting in Hartford, Conn., September, 1957.

Friction Characteristics of Flat Surfaces

By E. J. WEITER and A. O. SCHMIDT
Marquette University
Milwaukee, Wis.

Causes of frictional characteristics of selected material combinations and variations of their coefficients of friction are discussed here.

ACTUAL profiles of machined flat surfaces show large numbers of peaks and valleys. These peaks vary in size, shape, number, and location depending on physical properties of the material and method of finishing. Where direct contact of peaks is made be-

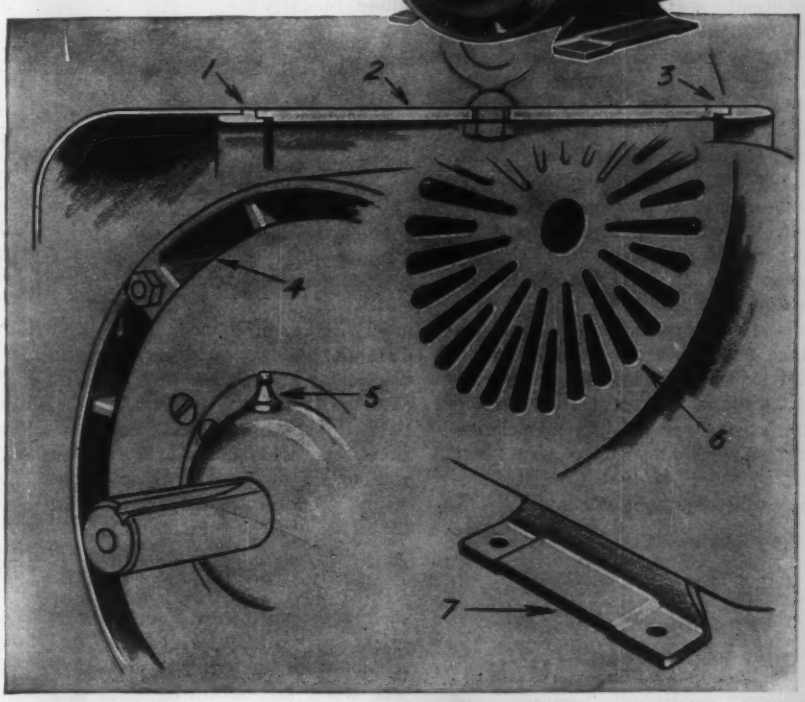
HOWELL MOTOR BRIEFS

Quick facts for those who apply and specify electric motors

Eye Appeal: New Requirement in Motor Design

As the trend to automation accelerates and the number of individual drives per machine increases, electric motors become, more than ever, an important element in the overall appearance of many machines. In designing the Howell Series 100 motors in the new frame sizes, Howell engineers set up the list of design requirements shown below. For evidence of how they met them, see the totally enclosed fan cooled motor at right and the detail sketches below it.

When you're specifying motors, why not specify for streamlined appearance — in addition to the top performance you need? It's a bonus value that costs no more and you'll be matching functional efficiency with sleek good looks.



HOWELL SERIES 100 TEFC EXTERIOR DESIGN REQUIREMENTS

❶ Fan cover, end-plate and frame to join so as to produce flush exterior surface.

❷ No fins, ribs or other protrusions, other than conduit box and feet, around entire diameter of frame.

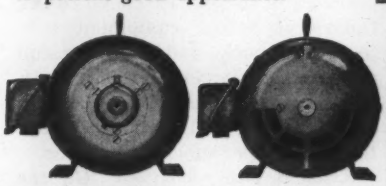
❸ Joint between frame and end-plate to present flush exterior surface.

❹ Ventilation ports to carry out contemporary streamlining, offer minimum obstruction to passage of air, and meet or better NEMA specifications for safety.

❺ Grease fittings, top-ball type, to be located for (1) easy accessibility (2) maximum protection against damage.

❻ Fan guard openings to incorporate distinctive design and to meet or exceed NEMA specifications for safety.

❼ Mounting feet to eliminate excess bulk and weight, utilize steel's strength to best advantage. Contours to present good appearance.



Open-type motors in the Howell Series 100 line match their TEFC counterparts not only in streamlined good looks, (see above right), but in diameter and mounting dimensions. Space allocations are simplified.

Series 100 enclosures: totally enclosed fan cooled, open drip-proof, splash-proof and weather protected, and totally enclosed non-ventilated.

Get complete details on these outstanding new motors today . . . write for Bulletin N-100-R

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Circle 489 on Page 19

tween two surfaces, there is the probability of welding at these contact areas.

Friction force, either static or kinetic, is the summation of the force necessary to shear the welded contact areas, the force required to plow the peaks of the hard material through the soft material, and the force needed to overcome interlocking of peaks.

When sliding surfaces are flat, random location and geometry of the peaks are important. There is a valid relationship between friction and material hardness since hardness is a measure of capacity to withstand shear. Also, true contact area is a function of normal load and hardness where two flat surfaces are brought together.

Coefficients of static friction, μ_s, for steady state conditions are not independent of time but are affected by the interval that contacting surfaces are at rest prior to sliding. Plastic deformation of peaks varies with the length of time that contacts are under load. Since plastic deformation is a time-dependent process, static friction increases within limits with respect to the time that contact areas are at rest before breakaway. Increase of friction is due to the enlargement of area. Also, since flow of lubricant in the contact area is a function of time, effect of the lubricant in reducing the coefficient of static friction varies with respect to time that surfaces are at rest prior to motion of component parts.

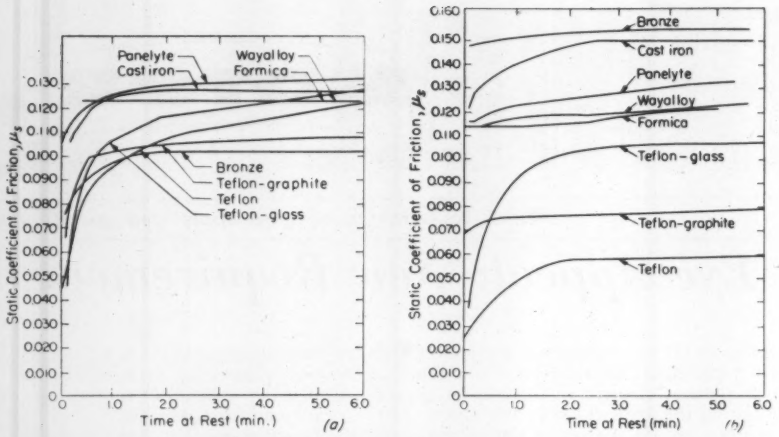


Fig. 1—Variation of coefficients of static friction with time at rest under load prior to motion of component parts. Hardened and ground steel slide, *a*, lubricated, 10 psi load. Ground cast-iron slide, *b*, lubricated, 50 psi load.

Friction behavior of the following slider materials was determined recently:

1. Formica.
2. Wayalloy A (plastic with wood filler).
3. Aluminum bronze.
4. Ground cast iron.
5. Panelyte.
6. Glass-filled Teflon.
7. Teflon.
8. Graphite-filled Teflon.

Slider materials were used with slides of hardened and ground steel and ground cast iron. Fig. 1*a* and 1*b* show variation of static coefficient of friction with time at rest under load.

With certain material combinations, coefficient of static friction attains a stable value after initial wear. Teflon-base materials show the largest rate of change in μ_s with time at rest because of low yield strength of Teflon. Aluminum bronze and cast iron also show a tendency for μ_s to increase, but at a lesser rate. Lubrication increases the effect of time at rest prior to motion. Coefficient of friction varies to a greater extent than it would if surfaces were dry, in which case increases in load decrease the variation. This is logical since extrusion of lubricant from the interface occurs in addition to plastic deformation.

From "Coefficients of Friction of Flat Sliders," presented at a joint session of the Metal Processing Research Committee and the Machine Design Div. at the ASME Semi-Annual Meeting, San Francisco, June, 1957.

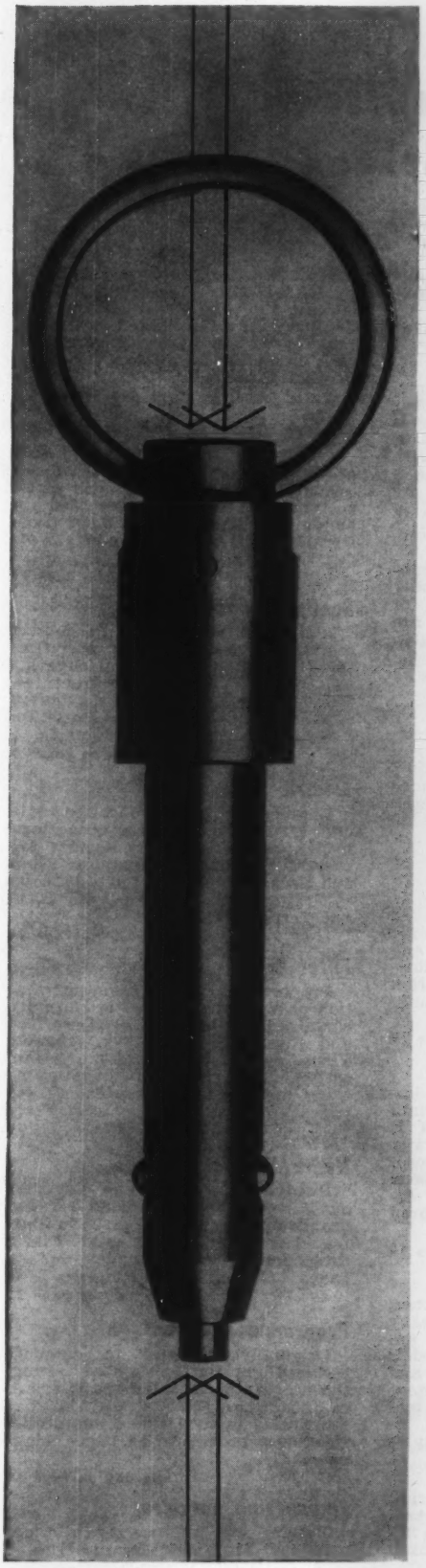
Protecting Equipment Against Shock

Known analytical concepts of modes of shock failure leave much to be desired. Development of valid criteria for solution of design problems under specific shock-load conditions is necessary.

DESIGN of equipment to withstand shock must be based upon quantitative data defining the shock, supplemented by appropriate design procedures for converting environmental data to design data. Quantitative data describing conditions of shock in aircraft, for example, are scarce due to cost and complexity of necessary test work for obtaining data and to lack of an accepted practice of data reduction. An appropriate data-reduction procedure must consider not only the nature of the original data but also the use to be made of such data.

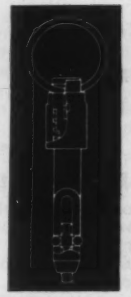
An accepted design procedure does not now exist because of a lack of understanding of factors which govern failure of equipment when subjected to shock. Hypotheses of such failures have been set forth, based upon an analogy with the failure of structural members subjected to repeated applications of stress. Until these hypotheses have been extended to the failure of actual equipment subjected to shock, and the extension validated by experimental investigations, there will not be the confidence in the ability of a designer to design for shock resistance.

From a paper entitled "On the Protection of Airborne Equipment Against Shock," by Charles E. Crede, Barry Controls Inc., Watertown, Mass., presented at the SAE National Aeronautic Meeting in Los Angeles, Calif., October, 1957.



DOUBLE-ACTING "B" SERIES

PIP® SELF-LOCKING QUICK-RELEASE PINS



the pin that's designed for positive release...even under "over-load" or "bound" conditions!

Double-acting PIP Pins combine rugged strength and dependability with INSTANT INSERTION, AUTOMATIC SELF-SAFETYING...QUICK RELEASE! It's the most dependable self-locking quick-release pin you can use!

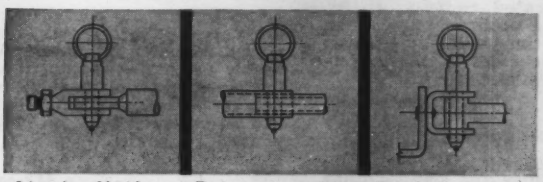
Now... eliminate nuts, bolts, cotter pins and other retaining devices and gain unlimited design freedom by using double-acting PIP Pins to fasten units that must be assembled and disassembled frequently. PIP Pins permit quick-change of mechanical units, speed assembly... reduce servicing costs.

Double-acting "B" Series PIP Pins have the special advantage of the exclusive PIP "drive-in"—"drive-out" feature... makes it easy to install or remove pin when misaligned holes or extra heavy loads cause "binding".

MEETS RIGID REQUIREMENTS

Double-acting PIP Pins are used by leading manufacturers of industrial, electronics, construction and materials handling equipment. Used by every major aircraft manufacturer. PIP Pins with "drive-in"—"drive-out" features are available in standard diameters to fit most nominal holes. "B" Series double-acting PIP Pins with continuous steel ring are particularly adaptable to remote release systems.

Let our Engineering Staff help you determine the correct solution to *your* quick-release fastening problem.



Clevis fitting Tube assembly Bracket assembly

DESIGN ENGINEERS—MANUFACTURERS: Write for your FREE copy of Brochure NO. ADI-5500. Contains specifications and technical data.

AVIATION DEVELOPMENTS INC.
210 S. VICTORY BLVD.
BURBANK, CALIFORNIA

PIP® SELF-LOCKING — PINS QUICK-RELEASE

Sales offices in principal cities
Manufacturers of PIP® Self-Locking Quick-Release Pins, Chobert® Rivets and Avdel Sheet Grippers.

Circle 490 on Page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Linear Amplifier

Built to Oak Ridge National Laboratory Specification Q1326, the Model 672 linear amplifier is designed to amplify pulses of low signal level from radiation detectors to usable levels for use in counting systems. It is described in Form 3001-7. 2 pages. Victoreen Instrument Co.

Circle 631 on Page 19

Dynamotor

Specifications are given in Data Sheet 15F5 on the 1500 Series dynamotor for use in guided missiles. It has input of 25 v at 1 amp and output of 225 v at 0.05 amp. 1 page. Induction Motors Corp.

Circle 632 on Page 19

Gas Detector

Capable of handling any type of hydrocarbon gas including that given off by jet engine fuels, the Model 104 A combustible gas detector is described in illustrated bulletin. Continuous sampling is possible from up to nine test locations. 4 pages. Hunter-Bristol Corp.

Circle 633 on Page 19

Semiconductor Soldering

Phase diagrams for the more popular Anchor soldering alloys used in semiconductors are included in handy reference chart. Also listed are high purity elements and their respective purities. Anchor Metal Co.

Circle 634 on Page 19

Radiant Heaters

Applications of radiant heating equipment in metal processing operations are described in case-history form in illustrated Bulletin 57-108. Product heating problems, processing temperatures, time cycles, and oven design are discussed. 8 pages. Fostoria Pressed Steel Corp.

Circle 635 on Page 19

Axles & Running Gears

Illustrated Catalog C-1 contains engineering drawings and specifications on axles and hubs, springs, drawbars, wheels, special running gear, and two and four wheel assemblies. Also covered is lightweight running gear, designed to Military Specifications, for air transportation and air drop. 34 pages. United Mfg. Co.

Circle 636 on Page 19

Flexible Couplings

Pertinent application and selection data on geared flexible couplings with maximum bores ranging up to 7 in. and with ratings from 2½ to 572 hp per 100 rpm are contained in illustrated Data Book 2775. Design provides for reasonable parallel and angular misalignment with a minimum of backlash. 12 pages. Link-Belt Co.

Circle 637 on Page 19

Clock Movements

Specifications, dimension diagrams, and descriptions of synchronous electric and 8-day spring-wound movements and fitups are contained in illustrated Bulletin 200. Types are available for wide range of clocks. 8 pages. E. Ingraham Co.

Circle 638 on Page 19

Bonded Metal-Rubber Parts

Bonding of molded mechanical rubber to metal, compounding of rubber for tailor-made jobs, and uses of metals cushioned with rubber are subject matter of illustrated booklet. 24 pages. Henry Engineering Co.

Circle 639 on Page 19

Remote Control Assemblies

Flexible shafts, flexible shaft couplings, universal joints, and push-pull controls are some of the light duty, remote control assemblies described in Catalog 5694. Full dimensional and application data are included. 12 pages. Kupfrian Mfg. Corp.

Circle 640 on Page 19

Phase Angle Voltmeter

Set-up diagrams and procedures for using Model VM-200 phase angle voltmeters in research, testing, and field applications are included in illustrated bulletin entitled "Application Notes." 16 pages. North Atlantic Industries, Inc.

Circle 641 on Page 19

Densified Wood

Composed of a series of resin-impregnated veneer sheets fused into a dense material, StaminaWood is usable for handles, trim, tops, trays, knobs, gears, and many other products or parts. What this material is and where it can be used is explained in booklet. 4 pages. Fibron Products, Inc.

Circle 642 on Page 19

Time Switches

New tungsten-rated time switches, especially designed to handle heavy duty incandescent lighting loads, are described in Catalog TS-89. Models include on-off, switch, Skipper, and short interval (5 to 60 minutes) switches. 8 pages. International Register Co.

Circle 643 on Page 19

Motor Starters

Application features, engineering details, simplified maintenance procedures, and components of new 30-in. deep, front-connected Limitamp control panels are discussed in Bulletin GEA-6331A. These high voltage, current limiting, fused starters are designed for co-ordinated control of squirrel-cage, synchronous, wound rotor, and multispeed motors. 12 pages. General Electric Co.

Circle 644 on Page 19

Surface Grinding Wheels

Details of standard types and sizes of Dayton surface grinding wheels available from stock, as well as of custom wheels, are presented in handy combination bulletin-specification sheet. 4 pages. Simonds Worden White Co.

Circle 645 on Page 19

Sealing Compounds

Illustrated bulletin on Permagum sealing compounds gives specifications of various types and suggests uses in equipment and structures. They are available also in extruded bead and ribbon forms. Presstite-Keystone Engineering Products Co.

Circle 646 on Page 19

Electric Terminals

Engineering and application data on ETCO terminals, connectors, blades, and attaching machines are presented in illustrated catalog. Types and sizes are available for practically every wiring need. 12 pages. Electric Terminal Co.

Circle 647 on Page 19

Filter Cloth

Properties and application information on wide range of filter cloth are contained in Bulletin 10. Described and illustrated are Nylon, Dacron, Vincel, Orlon, Dynel, Teflon, Saran, cotton, glass fiber, and polyethylene cloth and special filter papers. 8 pages. National Filter Media Corp.

Circle 648 on Page 19

Hydraulic Piston Rings

Ready-reference data for designers on Permaseal piston rings for hydraulic applications are given in illustrated manual, "Permaseal Piston Rings for Hydraulic Application." 6 pages. Grover Piston Ring Co.

Circle 649 on Page 19

Programmed Centrifuge

Originally designed to simulate rocket flight for accelerated testing, the programmed centrifuge described in illustrated Bulletin BR-2048 has other uses in rocket and missile development programs. 14 pages. Magnavox Co.

Circle 650 on Page 19

Engineering Services

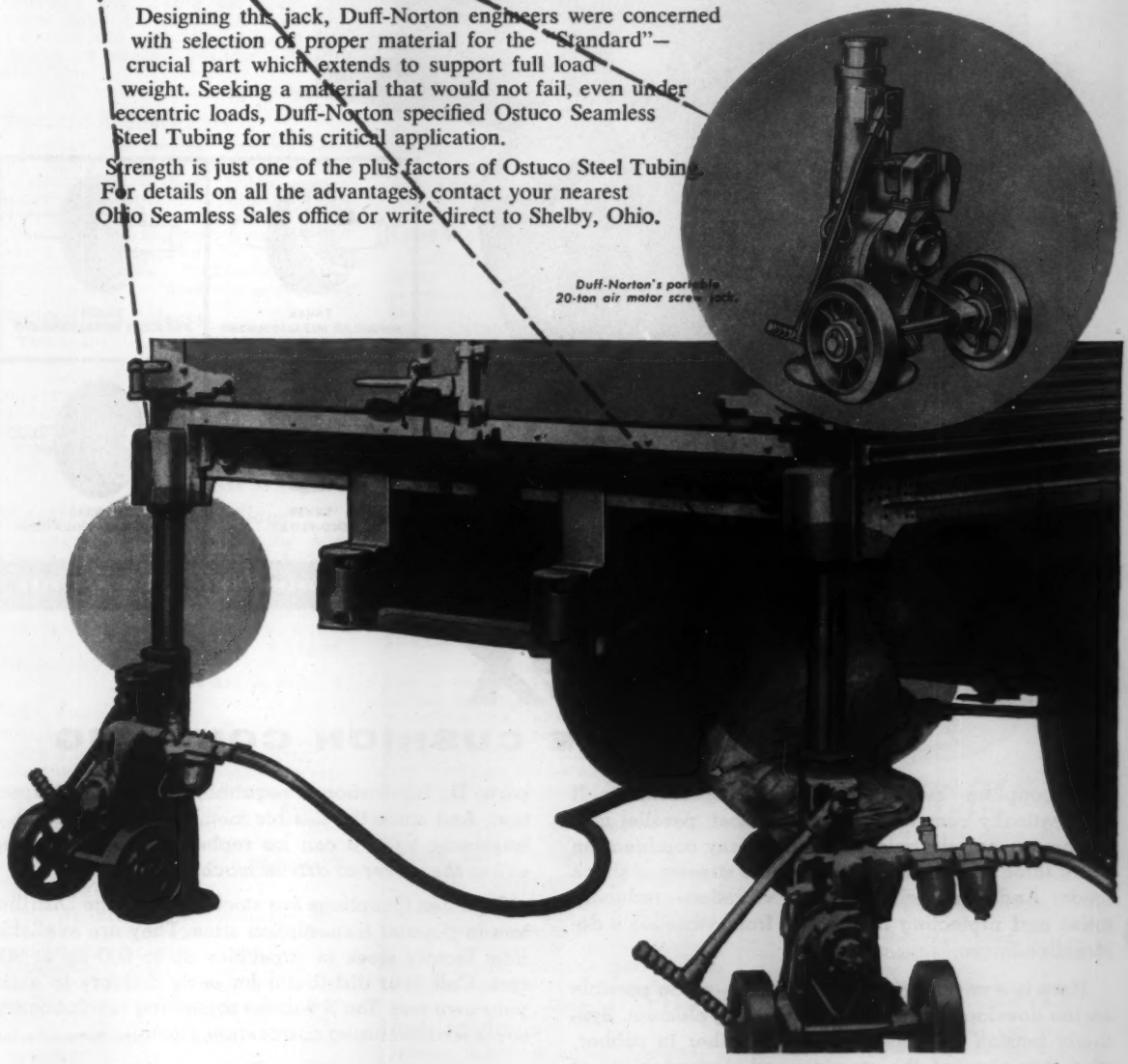
Design and engineering services available anywhere in the United

STRENGTH PROBLEM SOLVED with Ostuco Steel Tubing

Duff-Norton Company, Pittsburgh, manufactures a portable 20-ton air motor screw jack now finding wide acceptance as a maintenance tool by the trucking industry because of its versatility, dependability, and rugged strength.

Designing this jack, Duff-Norton engineers were concerned with selection of proper material for the "Standard"—crucial part which extends to support full load weight. Seeking a material that would not fail, even under eccentric loads, Duff-Norton specified Ostuco Seamless Steel Tubing for this critical application.

Strength is just one of the plus factors of Ostuco Steel Tubing. For details on all the advantages, contact your nearest Ohio Seamless Sales office or write direct to Shelby, Ohio.



Duff-Norton's portable 20-ton air motor screw jack.

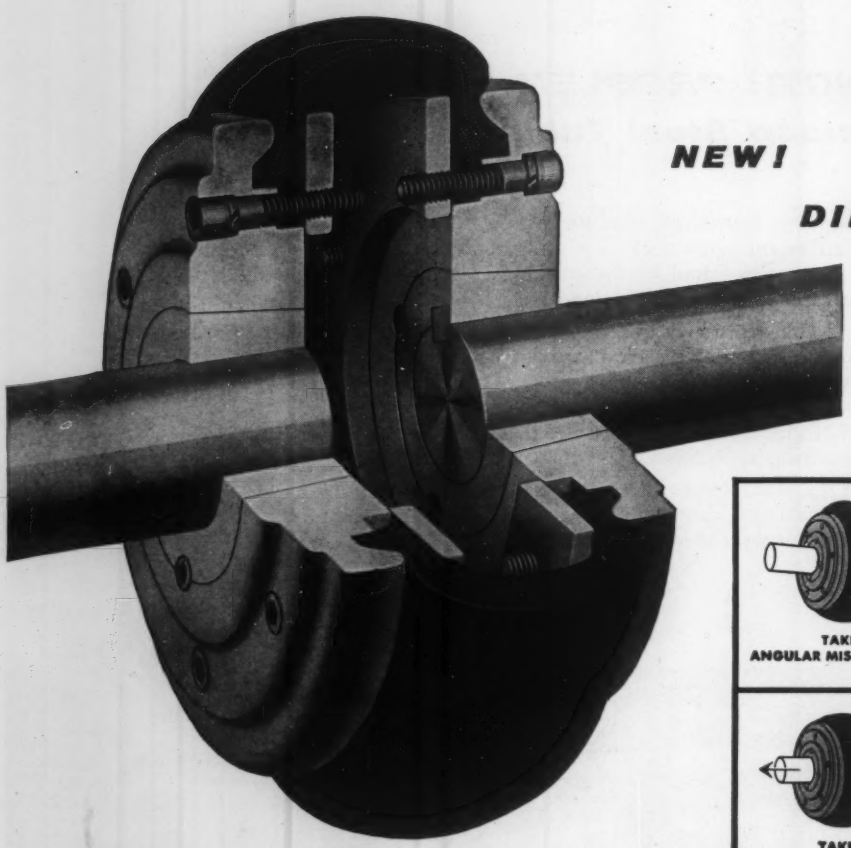
OSTUCO TUBING

MANUFACTURED IN
SHELBY, OHIO
EXCLUSIVELY BY

OHIO SEAMLESS TUBE DIVISION
OF COPPERWELD STEEL COMPANY

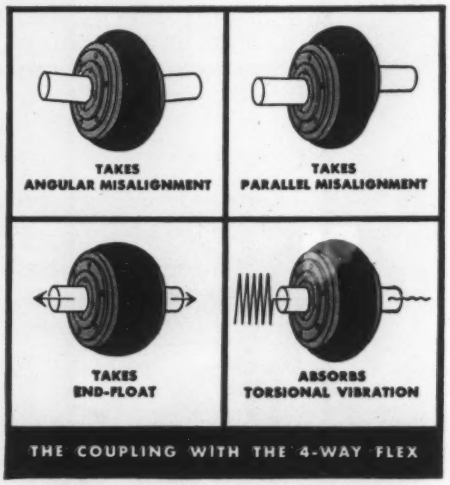
SHELBY, OHIO • Birthplace of the Seamless Steel Tube Industry in America
SEAMLESS AND ELECTRIC-RESISTANCE WELDED
STEEL TUBING • FABRICATING • FORGING

SALES OFFICES: Birmingham • Charlotte • Chicago (Oak Park) Cleveland • Dayton • Denver • Detroit (Ferndale) • Houston Los Angeles (Lynwood) • Moline • New York • North Kansas City • Philadelphia (Wynnewood) • Pittsburgh • Richmond Rochester • Salt Lake City • Seattle • St. Louis • St. Paul St. Petersburg • Tulsa • Wichita
CANADA: Railway & Power Engr. Corp., Ltd.
EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY, 225 Broadway, New York 7, New York



NEW!

DIFFERENT!



Announcing

Para•flex

FLEXIBLE CUSHION COUPLING

THIS coupling "swallows up" shaft misplacements. It automatically compensates for end-float, parallel misalignment, angular misalignment *or any combination of all three.* Moreover, it cushions the stresses of shock loads. And it absorbs torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

Here is a new type of performance—made possible by the development of a tire-like flexing element. Synthetic tension members, bonded together in rubber, give this element the stamina and dependability of modern, high-speed, high-load, shock-absorbing truck tires—and the ability to respond magically to all manner of changing shaft conditions.

Para-flex takes minimum space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. No lubrication is required, no periodic inspection. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine.*

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 600 hp at 900 rpm. Call your distributor for early delivery to *make your own test.* You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 3300 Union, Mishawaka, Ind.

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your classified telephone directory—or write us.

States to alleviate peak loads on existing engineering departments are described in illustrated brochure. Company employs digital computers to speed completion of projects. 6 pages. Allstates Design & Development Co.

Circle 651 on Page 19

Steel Collars

Illustrated bulletin 868 describes Hallowell steel shaft collars for shafts ranging in diameter from ⅛ to 3 in. Unbrako self-locking set screw secures collar on shaft. Also covered are solid and split types of cast iron collars. 4 pages. Standard Pressed Steel Co.

Circle 652 on Page 19

Sealants & Lubricants

Special and general purpose sealing compounds, cements, oils and lubricants, hydraulic fluids, valve grinding compound, polishes, and cleaners are some of the products for industrial, marine, and aviation use which are described in illustrated catalog. 8 pages. Permatex Co.

Circle 653 on Page 19

Decimal Equivalents

Two-color wall chart, featuring large easy-to-read numerals, gives six-place decimal equivalents for all fractions from 1/64 to 1 in increments of 1/64. Metal reinforced top and bottom, chart has brass eyelet for hanging and durable plastic permanized surface. Peninsular Steel Co.

Circle 654 on Page 19

Midget Thermocouple Gland

Measuring only 1½ in. long and with a ½-in. hex, the Conax Midget thermocouple gland provides positive seal for pressures from 0.005 microns to 5000 psi. They cover a temperature range of −300 to 1850° F. Specs are given in Bulletin MTG. 4 pages. Conax Corp.

Circle 655 on Page 19

Tank Turning Rolls

Illustrated Bulletin TR57 presents design and application information on tank turning rolls, pipe rolls, and rail cars for positioning cylindrical vessels for automatic welding. Speeds can be controlled to within 0.1 ipm. 12 pages. Aronson Machine Co.

Circle 656 on Page 19

Flow-Rate Meter

The Sho-Rate 150 rotameter described in Bulletin 121 has a 150-mm scale length for greater readability. Instrument meters small flows of gases or liquids and operates at 250° F and pressures to 200 psi. Specifications, capacities and dimensions are given. 2 pages. Brooks Rotameter Co.

Circle 657 on Page 19

Planned Wiring

"The Creative Approach to Better Wiring" is title of Brochure 60054 which effectively presents a complete planned wiring program and its adaptation to various products. Program not only evaluates wiring in terms of cost and time, but involves development of new terminals and tooling. Case histories are cited, as are some new developments in tooling. 20 pages. Aircraft-Marine Products, Inc.

Circle 658 on Page 19

Industrial Air Compressors

Combination data book and catalog provides designers and engineers with complete information on line of air compressors with ratings from ⅓ to 20 hp. Each model is described and full specifications are given. Formulas and engineering guidance are presented. 24 pages. Wayne Pump Co.

Circle 659 on Page 19

Welded Steel Tubing

Advantages provided by use of resistance welded mechanical tubing are explained in Bulletin TB-419. Mechanical properties and various size tolerances are detailed. 8 pages. Babcock & Wilcox Co., Tubular Products Div.

Circle 660 on Page 19

Tape-Wound Cores

Bulletin TB-102 describes the three types of core materials from which precision tape-wound cores are manufactured. Test procedures are covered. Catalog also contains information on protective boxes, vibration and shock procedures, and standard and special core sizes. 8 pages. G-L Electronics.

Circle 661 on Page 19

Metal-Probe Thermometers

Folder 4P757 provides details on two basic types of fast-reading metal-probe thermometers and shows configurations in which they are available. These are an integral-probe and remote-probe types. Listings cover accessory equipment as well. 4 pages. Royco Instruments.

Circle 662 on Page 19

Silicone-Base Lubricant

Applications of the silicone No. 44 grease described in Brochure 6-209 include lubrication of sealed bearings in appliances, kiln preheater fans, slasher and dryer bearings, plastic gears and cams, timers, and other uses involving temperatures from −40 to 400° F. 4 pages. Dow Corning Corp.

Circle 663 on Page 19

Timing Belt Pulleys

Available price and size sheet lists XL (extra light) ¼ in. pitch pulleys used with Gilmer and U. S. Powergrip timing belts. Pulleys with from 10 to 60 grooves are stocked. They have 0.234-in. circular tooth pitch. H. Neuman & Co.

Circle 664 on Page 19

Electrical Tapes

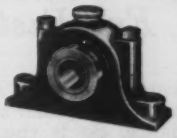
Folder E-PTAF which describes a complete line of improved Scotch thermosetting electrical tapes features a tabulation of typical properties. Tapes have up to 80 per cent higher initial adhesion. 4 pages. Minnesota Mining & Mfg. Co.

Circle 665 on Page 19

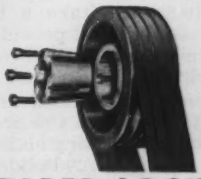
Data Automation System

Features of Univac II data automation system are described in illustrated manual. System boasts a mag-

DODGE PRODUCTS you should know



DODGE-TIMKEN
America's Quality Pillow Blocks!



TAPER-LOCK SHEAVES
Easy on—easy off! Mount flush!

TAPER-LOCK SPROCKETS
No reboring—no waiting!

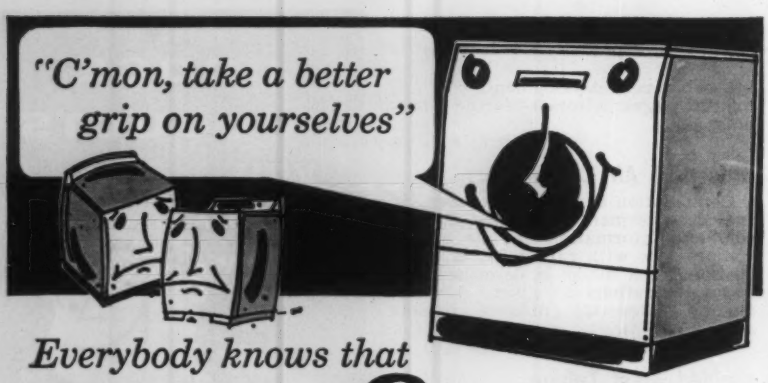
Write for Bulletins!

- Roller Bearings. Load ratings, dimensions, etc. Bulletin A-638.
- Taper-Lock Sheaves. Drive tables and technical data. Bulletin A-661.
- Taper-Lock Sprocket and Dodge Roller Chain data. Bulletin A-644.

DODGE MANUFACTURING CORPORATION
3300 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

Circle 493 on Page 19



Everybody knows that

SEMS BY Everlock®

End Fastening Problems for Good!

Appearance and quality are vitally important to consumer acceptance of any appliance. So is the durability with which the mechanical components are fastened together.

Sems by Everlock literally help your products to "take a better grip on themselves" and provide greater resistance to loosening through vibration, shock and heaviest use.

Sems by Everlock firmly grip both the fastener and the product with full chisel edge locking action . . . an Everlock exclusive . . . bulldog bite actually *tightens* when subject to vibration.

SEMS by Everlock Save Time and Money 5 Ways...

1. **Cut Costs** by eliminating separate handling of screw and washer.
2. **Simplify Ordering** by reducing the number of items in your plant inventory.
3. **Eliminate Waste** due to lost or dropped lock washers.
4. **Eliminate Rejects** due to omitted lock washers or faulty fastening.
5. **Fast Delivery** on a wide range of types and finishes.

SEMS by EVERLOCK
Exclusive Everlock Chisel Edges firmly grip both the fastener and the product!
Everlock Sems are available in a wide range of types and sizes. Ordering "Sems" is not enough, only Everlock Sems have the exclusive, full chisel edge-locking action.
Other Everlock fasteners that feature the exclusive full chisel edge-locking action include Free Lock Washers, Locknuts and Terminals.
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THOMPSON-BREMER & CO.
228 North LaSalle Street, Chicago 1, Illinois
Subsidiary of AMERICAN MACHINE & FOUNDRY CO.
Another AMF Product
Everlock
INDUSTRIAL FASTENERS
Check the Alphabetical Listing in your Telephone Book
EVERLOCK REPRESENTATIVES
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C. L. Martin Sales Corp. Baldwinsville, N.Y.
Richard C. Dudek Beverly Hills, Calif.
Plastic & Metal Components Boston, Mass.
W. L. Barth, Jr. Chicago, Illinois
Scott & Steffen, Inc. Cleveland, Ohio
Kenneth D. Delanoy Dayton, Ohio
Sam T. Keller Co. Detroit, Michigan
C. W. McNeil, Inc. Houston, Texas
D. G. Teeling Co. Indianapolis, Ind.
H. R. Paulson Co. Lansing, Mich.
A. G. Kavalar Milwaukee, Wis.
Thom Lundeen Moline, Illinois
J. Ramsey Reese, Inc. New York, N.Y.
Hank Workman Pleasure Ridge, Ky.
W. Henry Cordray Sales Co. Philadelphia, Pa.
Oregon Indust. Factors Portland, Oregon
Howard N. Clark Rochester, N.Y.
Forrest Moschner St. Louis, Mo.
AMF

Helpful Literature

netic core storage capacity of up to 120,000 characters, increased operating speeds and input-output capacity, and greater programming flexibility. 79 pages. Sperry Rand Corp., Remington Univac Div.

Circle 666 on Page 19

Carbon & Graphite Products

Chemical and physical properties that make National and Karbate carbon and graphite products suited to chemical processing and similar applications are listed in Catalog Section S-5008. Data cover heat exchangers, centrifugal pumps, entrainment separators, pipe and fittings, brick, structural shapes and cements. 4 pages. National Carbon Co.

Circle 667 on Page 19

V-Belting

Specifications and data provided in form 2022 on Bull Dog Roll Lot V-belting include equivalent length tables for endless V-belting replacements. Belting is available in A, B, C, and D cross sections in 250-ft rolls. 2 pages. Boston Woven Hose & Rubber Co.

Circle 668 on Page 19

Vibrating Packers

Complete information is provided in Bulletin 63 on two standardized vibrating packers having container capacities up to 350 and 500 lb. Units are used to settle and compact materials in boxes, bags, drums, and other containers. 4 pages. Ajax Flexible Coupling Co.

Circle 669 on Page 19

Punched Card Readers

Specifications Bulletin describes new line of static punched card readers for use with industrial processing and control systems. Operating characteristics, connector components, and top and bottom plate configurations are covered. Peerless Electric Co., Electronics Div.

Circle 670 on Page 19

Hot Water System Controls

To help in selection and use of controls for high temperature hot water installations, engineering folder features diagrams to show how pump controls, water feeders, and relief valves are used in these systems. Brief selection tables are included. McDonnell & Miller, Inc.

Circle 671 on Page 19

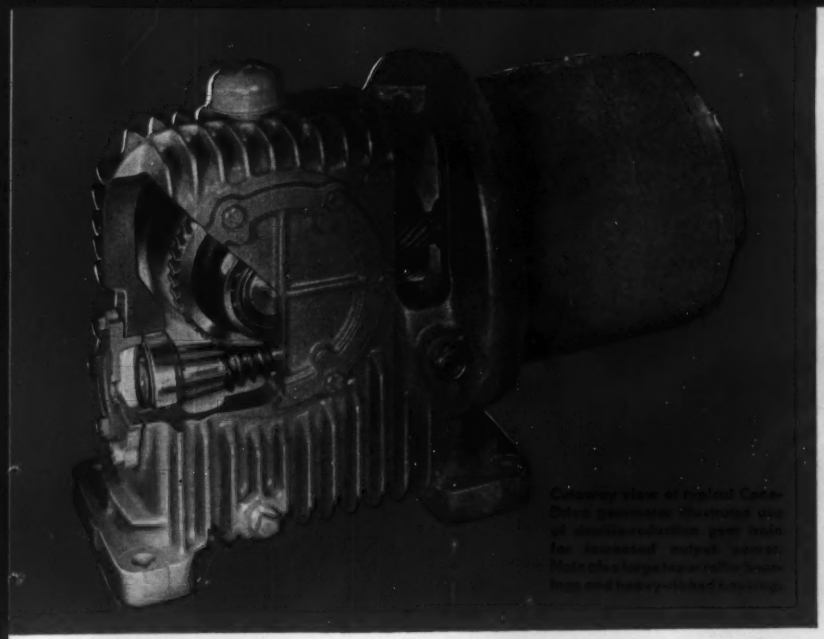
Stainless Steel Specifications

Government specifications on stainless steel are tabulated on chart of file card size. It shows chemical analysis for most military and federal uses and lists specified forms (bars, wire, etc.) with nearest corresponding SAE, AISI, and AMS type numbers. Peter A. Frasse & Co.

Circle 672 on Page 19

Connectors & Fasteners

Plastic screw anchor kit, plastic screw anchor-tube kit, lead anchor kit, Lok-It wire connector wrench for Bakelite wire connectors, six sizes of nylon cable clamps, fish tape winder, wire connectors, plastic clamps, conduit reamer and bender, and voltage testers are among elec-



Announcing a
POWERFUL NEW DRIVE
by
CONE-DRIVE GEARS

Here are the "why's" for this new gearmotor

Why a right-angle gearmotor?
You save space! By tucking the entire unit in close to the driven shaft, there's nothing to stick out in crowded aisles. It's out of the way.

Why a double-reduction design?
More power! Combining a helical primary with a Cone-Drive double-enveloping worm gear secondary gives you an extremely high load-carrying capacity. Output torque ratings are much higher than those of single reduction gearmotors. Overall ratios are greater, too.

Why double-enveloping worm gears?
More power! Cone-Drive double-enveloping worm gears have proven that they provide maximum load carrying capacity on extremely small center distances. This means, in many cases, that they will handle two to four times the load of cylindrical worm gears of the same size. An added plus is high resistance to shock loads, long operating life and minimum maintenance requirements.

Why different types of mountings?
Flexibility! You can select Cone-Drive gearmotors with extended shaft or for shaft mounting. Both are standard. Shaft mounting often permits "hanging" the driven load on the gearmotor to eliminate pillow blocks, bearings, torque arms, shafts, pulleys, bed plates, etc. Both types may be floor, wall or ceiling mounted as desired.

Why 27 standard output speeds?
Standardization! Standard reductions range from 3.3:1 to 240:1. Speeds at 1750 rpm input range from 525 rpm to 7.3 rpm output speed. Any variation in input speed will naturally provide another complete set of 27 output speeds. Any standard type NEMA D-flange motor may be used. Other reductions may be obtained on special order at additional cost.

Why ratings to only 25 horsepower?
Demand! Extensive market research by Cone-Drive Gears reveals that this is the most popular power range in the application of gearmotors by industry. Currently we are building models in capacities from 1 to 25 horsepower. However the compact size and high capacity of the Cone-Drive gearmotor will extend this range in the future. Space requirements for higher capacities will be substantially reduced with our new design.

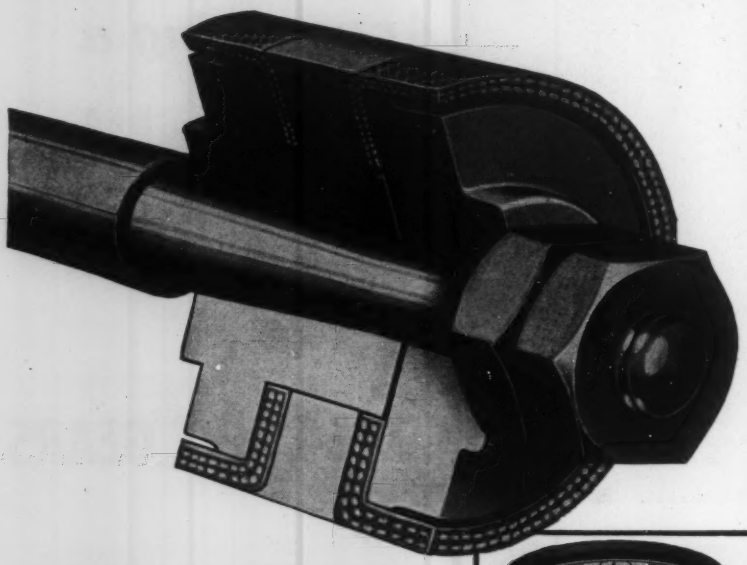
Why a Cone-Drive gearmotor?
Dependability! For over 20 years Cone-Drive Gears has been building double-enveloping worm gears and speed reducers. Design and manufacturing techniques have been constantly improved so that today these unique gears provide, size for size, the highest load-carrying capacity of any right angle worm gearing. Now, you can take advantage of this outstanding gearing combined into an integral package that eliminates pulleys, sheaves, belts, chain, bearings and all the trouble that goes with separate reducer and motor combinations. You'll get increased efficiency at lower cost by specifying standard Cone-Drive gearmotors.

Bulletin #57 contains complete details. Ask for it today.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN

◀ Here's the finest shaft mounted gearmotor on the market today. It is available in all sizes with ratings identical to other Cone-Drive gearmotors.

Circle 495 on Page 19



WHY PUMCUPS MAKE A DIFFERENCE

Darcova Pumcup

Darcova 45° Bevel Type Pumcup

- **in reciprocating pumps**
- **in air and hydraulic cylinders**

With Darcova Pumcups in your cylinders, there's less fluid slippage. High volumetric efficiency is maintained and Pumcups outlast other packings at least 3 to 1! There's less down-time! Lower power cost! Smoother operation! Less maintenance and replacement!

Longer life is the result of truly advanced cup engineering, including 100% nylon composition, plus a choice of types, textures and precision sizes to exactly match fluid, cylinder, pressure and temperature conditions.

These same factors contribute to prolonged high efficiency by permitting full advantage of the "cup principle". Thus fluid pressure always keeps Pumcups snug against cylinder wall, despite eventual wear, while the total frictional load is minimized.

Send for Bulletin 5503. It will give you *all* the facts.

DARLING VALVE & MANUFACTURING CO.

Williamsport 30, Pa.

DARCOVA — the Original Compression Cup

TRADE MARK PUMCUPS

Helpful Literature

trical products and fastening devices covered in Catalog 12-B. 38 pages. Holub Industries, Inc.

Circle 673 on Page 19

Electronic Equipment

Over 27,000 items of electronic parts and equipment are listed in the 1958 catalog. Among these are tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, printed circuit components, transistors, and communications equipment. Prices are included. 404 pages. Allied Radio Corp.

Circle 674 on Page 19

Neoprene Sheet

Data Bulletin 7 lists physical and chemical resistances of neoprene sheet. Company applies sheet or linings to tanks, ducts, and other equipment exposed to critical service. Metalweld, Inc., Protective Coatings Div.

Circle 675 on Page 19

Blind Bolts

Booklet 2-1007, describing blind bolts for high strength blind fastener applications, covers structural uses, design characteristics, application tools, and methods of installation. 8 pages. Hi-Shear Rivet Tool Co.

Circle 676 on Page 19

Investment Casting Alloys

This 11 x 17-in. chart tabulates composition and physical properties of commonly used ferrous and nonferrous investment casting alloys. Two sets of properties deal with metal in as cast, or annealed state, and as hardened castings. 2 pages. Alloy Precision Castings Co.

Circle 677 on Page 19

Chemical Feeding Pumps

Specifications on liquid metering pumps provided in Catalog 1136 make possible quick selection of the unit for any job. Included are recommendations for use in handling specific chemical, acids, and other liquids. 36 pages. Houdaille Industries, Inc., Manzel Div.

Circle 678 on Page 19

Electronic Apparatus

Line of transmitters, modulators, power supplies, and accessories for application in radar, communications, and tube development is listed in Folder MW 857. Many are illustrated and a total of 37 types are listed in a tabulation. 4 pages. Levinthal Electronic Products, Inc.

Circle 679 on Page 19

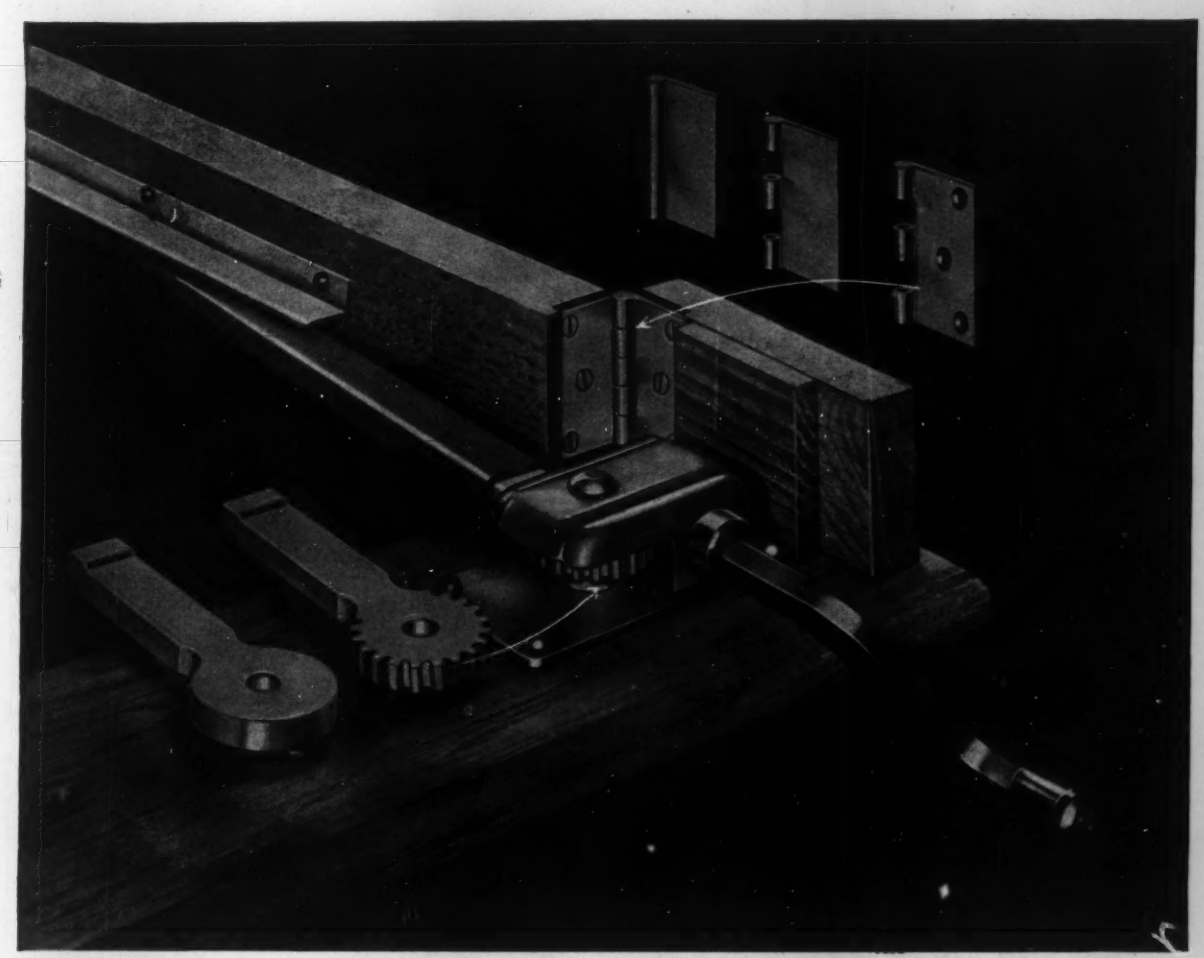
Check Valve

Vacuum-controlled gas-air check valve for gas and air reciprocating compressors not equipped with automatic unloaders is subject of Data Sheet WH 754. Its operation is outlined and available sizes and pressures are given. 1 page. Williams Gauge Co.

Circle 680 on Page 19

Anticorrosive Fasteners

Price, stock, and delivery information on lines of stainless steel and nylon fastenings is found in illustrated catalog. Items include bolts,



DEMONSTRATION UNIT for the Casement Window Operator, a product of The H. S. Getty & Company, Inc., subsidiary of Trans Continental Industries, Inc. At left on sill is Anaconda Die Pressed Forging for the operating arm gear. To its right is the finished part after trimming operations around circumference of gear head and in the hole—and hobbing teeth in. Upper right: hinge blank cut from long mill length of an Anaconda Extruded Shape — blank with slots milled and pinholes drilled in knuckles — finished hinge leaf.

How Anaconda die pressed forgings and extrusions cut costs for Getty*

Forgings save 30%. The H. S. Getty & Company, Inc., Philadelphia, is a leading manufacturer of marine, window and builders' hardware. They used to fabricate the operating arm gear for their casement window operator (above) from a leaded sheet brass stamping. The American Brass Company suggested a switch to die pressed forgings. Getty tried it, doing a trimming operation in the hole and periphery of the head — then hobbing in the teeth. Metal saving on each unit was 7 ounces. Machining was cut 10% — for an over-all saving of 30%.

Extruded shapes cut machining and finishing. The illustrations above right show the steps in fabricating Getty butt hinges from an Anaconda extruded shape. This short cut to a superior product gave Getty a simplified shop production routine that eliminated several costly machining and finishing operations — because the extruded shape has the exact cross section of the finished hinge. And, because of the dimensional accuracy of extruded shapes, each part is readily adaptable to drill jigs and milling fixtures. These precision hinges will perform well, too, because extruded metal is *wrought* metal — tough, strong, and dense-grained.

Find out how Anaconda short cuts can help you. If the production possibilities of die pressed forgings or extruded shapes look promising to you, send us a sketch, sample, or description of each part you have in mind. We'll be glad to tell you about costs — and about possible savings, too. Address: The American Brass Company, Waterbury 20, Connecticut. 8778

*Subsidiary of Trans Continental Industries, Inc.

ANACONDA®

DIE PRESSED FORGINGS

EXTRUDED SHAPES

MADE BY THE AMERICAN BRASS COMPANY

Circle 497 on Page 19

Speed Control Problems?

Let the Dynamatic Man Help You . . . He's an Expert!

More than likely the Dynamatic representative in your locality has had experience with a speed control problem about the same as yours. At any rate, he'll be glad to sit down with you and help work out the most practical and economical solution.

Dynamatic Eddy-Current Equipment—Drives, Brakes, Couplings—is solving speed control problems in every major industry, both in factory installations and on new equipment. Almost certainly some combination of these units will solve YOUR problem.

Your Dynamatic representative is fully qualified to make an intelligent appraisal of your problem, and suggest an application of Dynamatic Equipment that will do the most effective job for you. He has the background and experience to approach your problem with complete understanding. Why not call or wire the Dynamatic representative nearest you today—there's no obligation.

Illustrated Literature Describing Dynamatic Speed Control Equipment is Yours for the Asking

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
Kenosha, Wisconsin

CALL THE DYNAMATIC®

REPRESENTATIVE NEAREST YOU

ATLANTA, GEORGIA
The Gearhart Company
The Gearhart Bldg.

BALTIMORE, MARYLAND
Eaton Manufacturing Company
2118 St. Paul Street

BIRMINGHAM, ALABAMA
Eugene T. Sharley
Homewood Station, Box 5987

BUFFALO, NEW YORK
H. H. Cardozo, 5469 Main Street

BUTTE, MONTANA
G. M. Wallace & Company, Box 208

CHARLESTON, WEST VIRGINIA
Henry E. Payne
918 Kanawha Blvd. East

CHARLOTTE, NORTH CAROLINA
Electro-Motion Corp.
217 West Morehead Street

CHICAGO, ILLINOIS
Eaton Manufacturing Company
Arcade Bldg., One Riverside Rd.

CINCINNATI, OHIO
Gregg & Spohn, 1416 Bonnell Ave.

CLEVELAND, OHIO
Eaton Manufacturing Company
13600 Kuhlman Ave.

COLUMBUS, OHIO
Gregg & Spohn, 1738 Fifth Ave.

DALLAS, TEXAS
Lynn Elliott Company
1008 Fidelity Union Life Bldg.

DENVER, COLORADO
G. M. Wallace & Company
324 Denham Building

DETROIT, MICHIGAN
Eaton Manufacturing Company
10208 West McNichols Road

(Continued on following page)

DYNAMATIC REPRESENTATIVES

(Continued)

FLINT, MICHIGAN
Henry Electric Company
1209 Boston Ave.

GRAND RAPIDS, MICHIGAN
E. B. Dewey Company
314 Straight Ave., S.W.

HOUSTON, TEXAS
Lynn Elliott Company
371 M & M Building

INDIANAPOLIS, INDIANA
Gregg & Spohn, 5416 College Ave.

KALAMAZOO, MICHIGAN
E. B. Dewey Company
2519 Lake Street

KANSAS CITY, MISSOURI
Boyd Goodhart & Associates
Merchandise Mart Bldg., 2201 Grand Ave.

LOUISVILLE, KENTUCKY
Cardinal Carryor Co., Inc.
930 East Mason Street

MEMPHIS, TENNESSEE
Tom Jones, Mfr's Rep.
651 South Cooper Street

MIAMI, FLORIDA
The Gearhart Company
9731 Dominican Drive, Cutler Ridge

MILWAUKEE, WISCONSIN
Albert F. Korf & Company
3545 North Maryland Ave.

MINNEAPOLIS, MINNESOTA
Bemis Johnson Company
1645 Hennepin Ave.

MONTREAL, QUEBEC, CANADA
George Rumble Company, Ltd.
690 St. Paul St. West

NEW ORLEANS, LOUISIANA
Mid-South Sales Company
4424-B Earhart Boulevard

NEW YORK, NEW YORK
Gregg & Associates, U. S. Route 47,
Box 329, Caldwell Twp., New Jersey

NORTHBORO, MASSACHUSETTS
Machinery Electrification, Inc.
35 Hudson Street

PASADENA, CALIFORNIA
Shaw Engineering Sales Co., Box 590

PHILADELPHIA, PENNSYLVANIA
Eaton Manufacturing Company
5921 North Broad Street

PITTSBURGH, PENNSYLVANIA
J. A. Malady Company
4135 Brownsville Road

PORTLAND, OREGON
Donal Company, Box 7013

RICHMOND, VIRGINIA
Herbert J. Baer, 304 East Main Street

ROCHESTER, NEW YORK
H. H. Cardozo
414 Reynolds Arcade Bldg.

SAGINAW, MICHIGAN
Henry Electric Company
1716 South Jefferson

ST. LOUIS, MISSOURI
A. M. McIntyre, 8226 Buchanan

SALT LAKE CITY, UTAH
G. M. Wallace & Company
Continental Bank Bldg.

SAN FRANCISCO, CALIFORNIA
Monarch Corporation
55 New Montgomery Street

SAN LEANDRO, CALIFORNIA
Monarch Corporation, Supply Division

SANTA CLARA, CALIFORNIA
Monarch Corporation
2455 The Alameda

SANTURCE, PUERTO RICO
Ramon I. Gil, Box 9182
Santurce Station

SEATTLE, WASHINGTON
Caskey Engineering Co.
2200 First Ave. South

STONERSVILLE, PENNSYLVANIA
E. F. Le Noir

TARIFFVILLE, CONNECTICUT
Gregg & Associates, 5 Fairfield Road

TORONTO, ONTARIO, CANADA
George Rumble Company, Ltd.
Terminal Building

VANCOUVER, BRITISH COLUMBIA, CANADA
Progressive Supplies Ltd.
360 West First Ave.

WASHINGTON, D.C.
Commercial Engineering Co.
1627 K Street N.W.

Helpful Literature

nuts, screws, and washers. Prices are shown for all quantity brackets. Nonstock items are also covered. 138 pages. Anti-Corrosive Metal Products Co.

Circle 681 on Page 19

Spring Wire

Selector guide for nickel alloy spring wire discusses five methods of heat treatment of nickel alloys and processing of springs. Recommended thermal treatments are also shown. Thirteen nickel alloy springs are listed on chart. Techalloy Co.

Circle 682 on Page 19

Limit Stop Assembly

Ten-turn miniature limit stop assembly, with or without potentiometer, is subject of Bulletin A105. Mechanical stops can be adjusted to any position or number of turns from 0 to 10. Specifications and illustrations of available units are included. United Hydraulics, Inc.

Circle 683 on Page 19

Transparency Kit

Method for making transparencies for overhead projectors from all types of transparent, opaque, two-sided, or bound original materials is described in bulletin on the Ozalid Projecto-Printer Kit. It utilizes dry developing diazo and reflex photo-copy methods. 6 pages. General Aniline & Film Corp., Ozalid Div.

Circle 684 on Page 19

Chassis Latches

Descriptions, drawings, specifications, and operating instructions for 21L and 27L electronic chassis latches are content of Bulletin 27L. Details of interchangeable handle and fork assemblies are included. 4 pages. Camloc Fastener Corp.

Circle 685 on Page 19

Conduit & Cable Fittings

Fittings for conductors and raceways are included in illustrated Bulletin 85 on electrical conduit and cable fittings. Each is described, and its operating and installation features outlined. 62 pages. Thomas & Betts Co.

Circle 686 on Page 19

Stainless Fasteners

First section of stainless fastener catalog includes illustrations, thread, and design specifications for 40 basic fastening devices of various corrosion resistant metals. Second section covers engineering data on composition, properties, applications, and weights of stainless steels. 52 pages. All-metal Screw Products Co.

Circle 687 on Page 19

Copying Equipment

Xerographic copying process is explained in illustrated Brochure X275 which also details use of each piece XeroX copying equipment. List of everyday uses and general duplicating requirements is included, along with cost-cutting suggestions. 8 pages. Haloid Co.

Circle 688 on Page 19

Hose & Hose Assemblies

Chemically resistant high and medium temperature hose and hose assemblies, subject of illustrated brochure, are suited for conveying such liquids, gases, or other mediums as concentrated and diluted acids, alkalies, hot adhesives and lacquers, liquid oxygen, and hot oils. 12 pages. Resistoflex Corp.

Circle 689 on Page 19

Servo System Components

"Mechatronic Development Apparatus" is title of catalog which lists over 200 components used in control equipment for automatic operation. Included are amplifiers, potentiometers, modulators, power supplies, motors, synchros, breadboard equipment, and packaged units. Section is devoted to mechatronic apparatus and servos. 52 pages. Servomechanisms, Inc., Mechatrol Div.

Circle 690 on Page 19

Voltage Regulators

Twelve case histories on the use of Regohm voltage regulators in various fields are found in Booklet 5.00.2. It relates how these units provide precise control of voltage, current, or speed and improve servo system performance. 28 pages. Electric Regulator Corp.

Circle 691 on Page 19

Hydraulic Valves

Revised hydraulic valve Catalog 551 contains up-to-date information on relief, check, and flow control valves. Each type is illustrated, and size and performance data are included. Section is devoted to valve selection. 16 pages. Fluid Controls, Inc.

Circle 692 on Page 19

Stainless Steel Bar & Wire

Case history Booklet P. O. 2157 details how fabricators have improved product design and performance with 17-4 PH and 17-7 PH stainless steel bar and wire. Serrated dials, high pressure valves, springs, pump shafts, and valve plugs are among applications. Properties of these and precipitation hardening stainless steels are given. 20 pages. Armco Steel Corp.

Circle 693 on Page 19

Microwave Ferrite Devices

Vol. 1 No. 1 Technical Bulletin of Microwave Electronics Div. is devoted to microwave ferrite devices, their underlying physical phenomena, a guide to ferrite devices, and an example of a hypothetical system which relies heavily upon ferrite components to achieve optimum performance. Initial illustrated issue has 8 pages. Sperry Rand Corp.

Circle 694 on Page 19

Engineered Fasteners

"A Critical Re-Examination of the Price-Per-Thousand Purchase Policy" explains how cost reduction can be obtained through preassembly and quality improvement in the field of fa enings. Discussed are Sems screw-lock washer, Keps nut-lock washer, and other fasteners engineered for production application. 22 pages. Write on letterhead to Illinois Tool Works, Shakeproof Div., St. Charles Rd., Elgin, Ill.

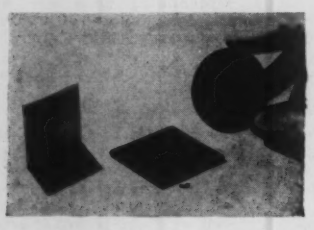
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Glass-Kel-F Materials

have high strength and rigidity

Fluoroglas and Fluoromat have proved effective as liquid nitrogen or oxygen seals, and high-temperature diaphragms. They provide higher strength at temperatures approaching absolute zero and greater rigidity at 425 F and above, in addition to usual properties of Kel-F. Fluoromat is a laminate of Kel-F, reinforced with fine glass fiber grids. Fluoroglas



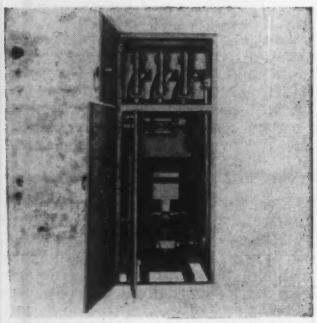
is reinforced with 15 to 18 per cent by weight of micro-pulverized glass filaments. Fluoroglas is available as a translucent-flexible or opaque-rigid material, depending on thickness, which starts at 0.008 in. Fluoromat is rigid and translucent to opaque, depending on thickness, which starts at 0.312 in. Both are available at present in sheets 1 ft square. **Fluorulon Laboratories Inc.**, P. O. Box 305, Caldwell, N. J.

Circle 695 on Page 19

Motor Starters

are 2300 to 4160-v units

Type H motor starters are for full or reduced-voltage starting, reversing or nonreversing, dynamic braking or multispeed control of squirrel-cage, synchronous, or wound rotor motors. They have



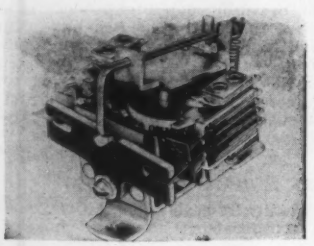
either air break or oil-immersed contactors rated up to 1500 hp at 2300 v, or 3000 hp at 4600 v. Short-circuit protection of 150,000 kva at 2300 v and 250,000 kva at 4160 or 4600 v is provided by current-limiting fuses. Basic units measure 34 in. wide by 32 in. deep. **Allis-Chalmers Mfg. Co.**, P. O. Box 512, Milwaukee 1, Wis.

Circle 696 on Page 19

Latching Relay

is single-coil alternate-pulse unit

PC single-coil latching relay selects alternate circuits or alternate circuit modes on successive impulses. It employs an armature-driven, rocker-type actuator to transfer one, two, three, or four double-pole, double-throw snap switches. Gold-flashed silver cadmium oxide contacts are rated at 10 amp 115 v ac resistive. Relay can be operated from ac or dc sources and provides positive transfer on a single 30-millisec impulse. Applications include remote TV controls, garage door openers, flow-control motors, and other applications requiring transferring between alternate circuits at undefined periods. **Potter & Brumfield Inc.**, Princeton, Ind.

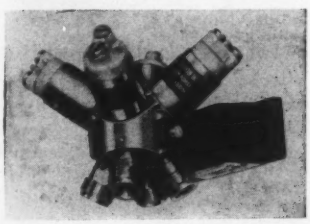


Circle 697 on Page 19

Transfer Coaxial Switch

for frequencies to 5000 mc

This transfer coaxial switch permits crossover and/or double-pole transfer switching of coaxial cable. Small and lightweight, it is for frequencies up to 5000 mc. Wide



flexibility in circuit switching is provided by independently operating solenoids. Switch is adaptable to coil voltages from 28 to 120 v dc, and is furnished with N-type connectors. It meets MIL-E-5272A. **Transco Products Inc.**, 12210 Nebraska Ave., Los Angeles 25, Calif.

Circle 698 on Page 19

Beam Switching Tubes

have ten individual constant-current outputs

Magnetron beam switching tubes have high input impedance and ten individual constant-current out-

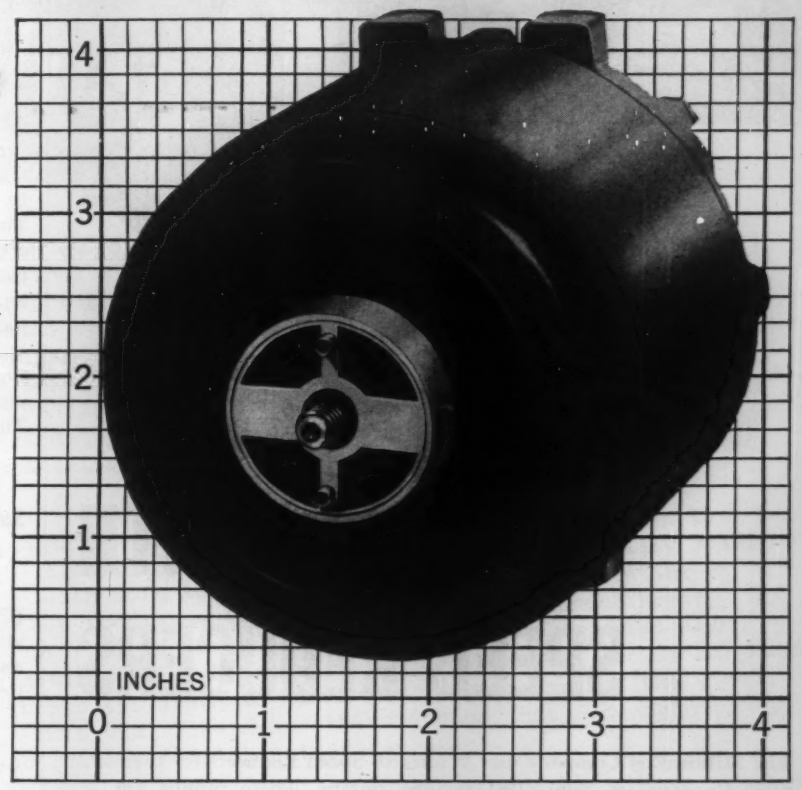
New Lightweight Single-Bearing Redmond Motor Warranted Two Years for Customer Satisfaction

HOW TRI-FLUX DESIGN IMPROVES PERFORMANCE BY ADDING A 3rd AREA OF MAGNETIC FLUX

The salient pole single phase induction motor has only one flux path—indicated by the white circle—between the field and the rotor. The motor is not self-starting—for commercial value a starting mechanism must be added.

The second white circle indicates the flux path added by wrapping a shading coil around the trailing pole tip. Power and uni-directional action are increased in this shaded pole induction motor, and it is now self-starting. This motor is now practical at low cost, and is used for applications requiring limited starting torque.

Note that a third flux path has been added at the leading pole tip. This was accomplished by Redmond's Tri-Flux design, whereby a "reluctance notch," which can be seen in the third white circle, is put in the leading pole tip. Efficiency and starting and running torques are greatly increased. New applications are opened to these improved, low-cost motors.



Designed Specifically for the Refrigeration and Air Conditioning Industries and Adaptable for a Wide Variety of Applications

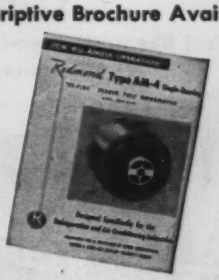
The Redmond AM-4 single-bearing Monomotor is ideal for applications where a long life, quality motor is required. Built to give outstanding performance over years of continuous service-free use, this assurance of customer satisfaction is backed by Redmond's full two-year warranty.

Outstanding features of the new AM-4 are all-angle operation and interchangeability to accommodate all standard brackets and special mounts. Made of a durable lightweight metal, this new single-bearing motor is considerably lighter than conventional models. A new positive oil system is used that is guaranteed not to leak oil in use or in shipment. The extra large oil reservoir is permanently sealed for lifetime lubrication.

Among the many features of the new AM-4 are two that are available only in Redmond small-diameter motors. They are: 1) Patented Tri-Flux design, described in the column to the left, which increases the efficiency and starting and running torques of the AM-4 over conventional single-bearing motors. 2) Uni-Cast construction, which assures a rugged, yet smooth, quiet motor as the stator core frame is precision die cast in one piece, enabling extremely close tolerances to be maintained during manufacture.

Rated at 1½ through 16 watts, the AM-4 MonoMotor is of 4-pole design, 1550 r.p.m., 115 volts, 60 cycles, and is also available in odd voltages and frequencies.

Descriptive Brochure Available

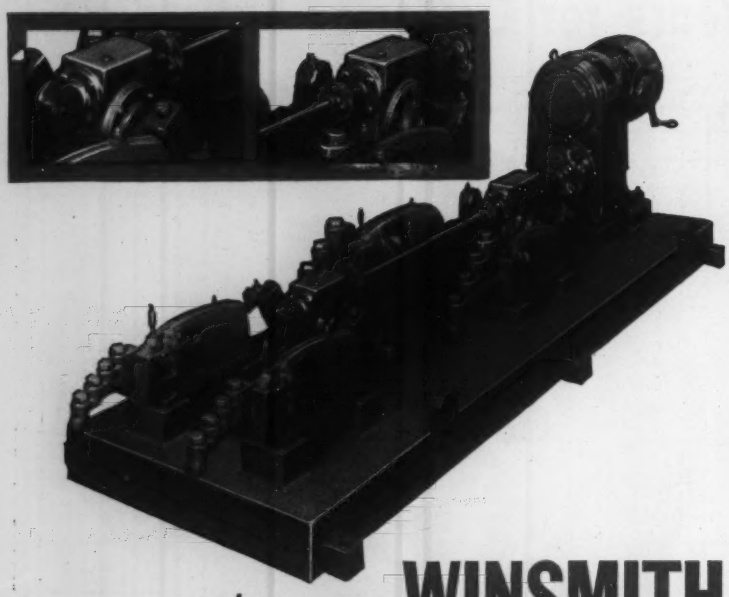


For the complete story on the new AM-4 motor—dimensions, performance, operational data, and suggested applications—write the Redmond Co., Owosso, Michigan for the "AM-4 Bulletin."

Circle 499 on Page 19

MILTON ROY CO.

considers "Quality" first



they use **WINSMITH**

SPEED REDUCERS

The Milton Roy Company uses Winsmith Speed Reducers for their precisely accurate, controlled volume pumps. These pumps are used in thousands of industrial installations where corrosive chemicals must be metered against positive heads to 25,000 pounds per square inch.

Winsmith Speed Reducers were selected for many reasons — their large overhung load capacity, rugged construction, price advantage, good delivery and trouble-free performance in service. "Quality", however, tops the list. As Milton Roy explains it, "... one of the most important factors in our use of Winsmith Speed Reducers is that they best fit our standards of quality."

We'd like to show you all the advantages of standardizing on Winsmith Speed Reducers for every application from 1/100 to 85 H.P. For complete selection information and engineering data, write — on your company letterhead, please — for Catalogs 155 and SM-57.

WINSMITH SPEED REDUCERS

WINSMITH, INC.

16 Elton Street, Springville, (Erie County), N. Y.

New Parts

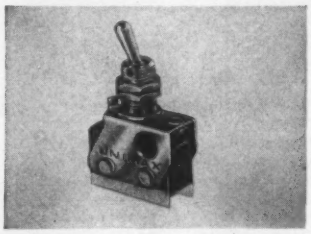
puts. They may perform the functions of 20 or more tubes or transistors. Tubes resist shock to 375 g and vibration to 20 g. They operate in a temperature range of − 60 to 150 C. Tubes can be used in instruments, industrial control computers, telemetering, and radar. They have many applications in frequency dividing, timing, and multiposition distributing. **Burroughs Corp.,** Electronic Tube Div., Plainfield, N. J.

Circle 699 on Page 19

Subminiature Switch

is toggle-actuated unit for panel mounting

USMB-1 snap-acting switch provides single-hole panel mounting, and a toggle-actuator mechanism. Connection terminals at rear of



switch housing handle wires up to No. 18. Switch is rated at 2½ amp 30 v dc inductive, 4 amp 30 v dc resistive, and 5 amp 125-250 v ac. **W. L. Maxson Corp.,** Unimax Switch Div., Ives Rd., Wallingford, Conn.

Circle 700 on Page 19

Self-Contained Microsyn

fits into 1-cu in. space

Ultraminiaturized self - contained microsyn has sensitivity of 500 mv per deg with a threshold of 0.01 deg at 20 v excitation. Intended for applications requiring accurate

Circle 500 on Page 19

Circle 501 on Page 19→

STAR-KIMBLE *reports to industry*

One of a series of advertisements describing unusual electro-mechanical problems solved by S-K engineering and equipment. You may have a similar problem—or a completely different one. In either case, bring it to Star-Kimble.

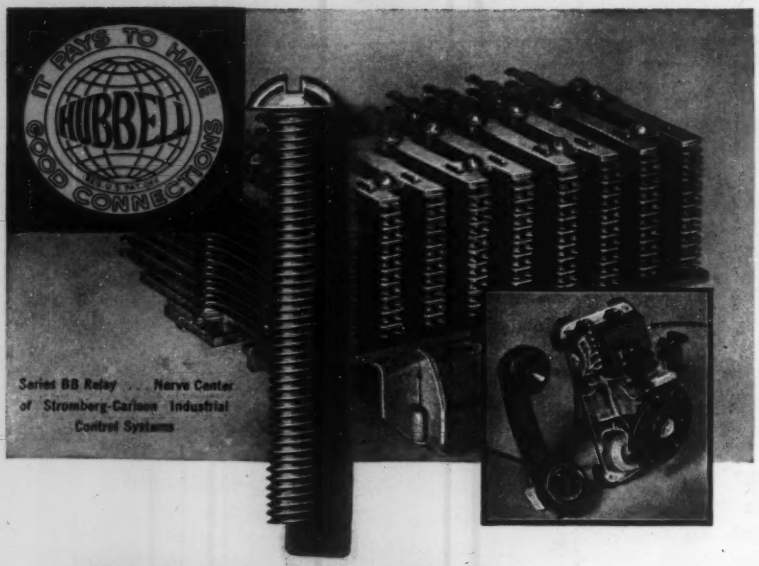
NON-STOP MOTORS POWER "PINETREE" RADAR ANTENNAS — In remote stations along "Pinetree," the defensive radar ring that girdles the U. S., equipment must operate day and night in extremes of weather with a minimum of maintenance. A vital component in these installations is the motor that rotates the radar antenna. If it fails, there is a miles-wide hole in the fence. In many of these stations, S-K motors, custom engineered for the purpose, are used for this critical job. Specifications are classified, but S-K met performance requirements rarely matched in any industrial application.

FOR A HARD JOB, A SOFT TORQUE — A leading Hoist manufacturer chose S-K to power their rugged electric hoists. The job called for a trolley motor and electric brake with soft torque for quick, but smooth spotting of heavy loads. Another requirement: a dust- and weather-proof hoist motor with plenty of reserve power for over-loads. S-K supplied all three — trolley motor, brake, hoist motor — and each has proved in years of service that it has the brawn to handle heavy loads around the clock, indoors and out. This OEM, like many others, found that S-K engineering and equipment were readily adaptable to a tough job.

SUPER POWERED "TRAINING" TORPEDO MOTOR — Unusual features of torpedoes used in ballistics training necessitate absolute minimum size motors with maximum horsepower and very high torque requirements. Life of these DC propulsion motors is very short — based on 30 minute cycles — covering a maximum expected life of no more than 25 cycles. Meeting the delivery deadline, S-K engineers met all these stringent specifications with acceptability of the prototype machine without a single change — a feat possible only for a company geared to this type of specialized application for so many years.

STAR-KIMBLE INDUSTRIAL MOTOR DIVISION
SAFETY INDUSTRIES, INC.
P. O. BOX 904 NEW HAVEN, CONN.

MOTORS • GENERATORS • DISK BRAKES • SPECIAL ROTATING AND CONTROL PACKAGES


IT PAYS TO HAVE
HUBBELL
GOOD CONNECTIONS
Series BB Relay . . . Nerve Center of Stromberg-Carlson Industrial Control Systems

SECURED with HUBBELL

HIGH TENSILE STRENGTH STAINLESS STEEL MACHINE SCREWS

Nerve center of many Stromberg-Carlson industrial controls is the multi-contact relay above, each contact spring and insulator of which is carefully sandwiched together and compressed under high pressure, ready for insertion of the binding screws. In order for the relay to operate satisfactorily the binding screws must maintain these high pressures so that the contact springs cannot and will not twist, loosen and shift position.

Ordinary machine screws just couldn't "stand the gaff". They stretched and broke under the strain, thereby causing endless production and maintenance headaches. Only after Stromberg engineers had set a rigid performance standard could the solution be found. Hubbell high tensile stainless steel machine screws made to Stromberg-Carlson specifications, proved to be the answer.

Lowest Cost To Service

Quite obviously, better materials and components add to the initial cost of any product. But how about the long term cost? When a product assembles quickly and easily, performs satisfactorily and requires a minimum of maintenance, the initial "extra" cost is quickly offset. Are you putting this time-tested principle into practice? Start today by specifying Hubbell quality fasteners.

Prices and delivery on request. Simply send blueprint or sample of the item.

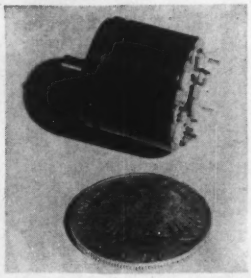
HARVEY HUBBELL, INC.

HIGHEST QUALITY
WIRING DEVICES • MACHINE SCREWS

OVER 60 YEARS' EXPERIENCE in the manufacture of highest quality, rolled thread machine screws and special cold headed parts.

MACHINE SCREW DEPARTMENT BRIDGEPORT 2, CONNECTICUT

New Parts



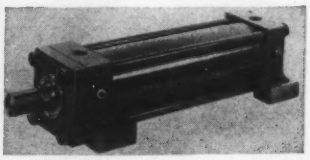
translation of angular displacement into electrical signals, units may be used in position-indication of gyros, control follow-up devices, etc. Excitation may be 20 v, 400 cps or 25 v, 800 cps. Linearity is within 0.5 per cent to 7 deg; weight is under 1.2 oz. Lear Inc., 110 Ionia Ave. N.W., Grand Rapids 2, Mich.

Circle 701 on Page 19

Hydraulic Cylinders

from 1½ to 12-in. bores for service to 3000 psi

Squarehead hydraulic power cylinders are for service at 2000 psi, or 3000 psi in nonshock installations, and are tested at 4500 psi before delivery. Made to JIC



standards, cylinders are available in bores from 1½ to 12 in. with all mountings standardized for interchangeability. Cylinders are double acting, with or without cushions. **Wellman Engineering Co.**, Anker-Holth Div., 2723 Connor St., Port Huron, Mich.

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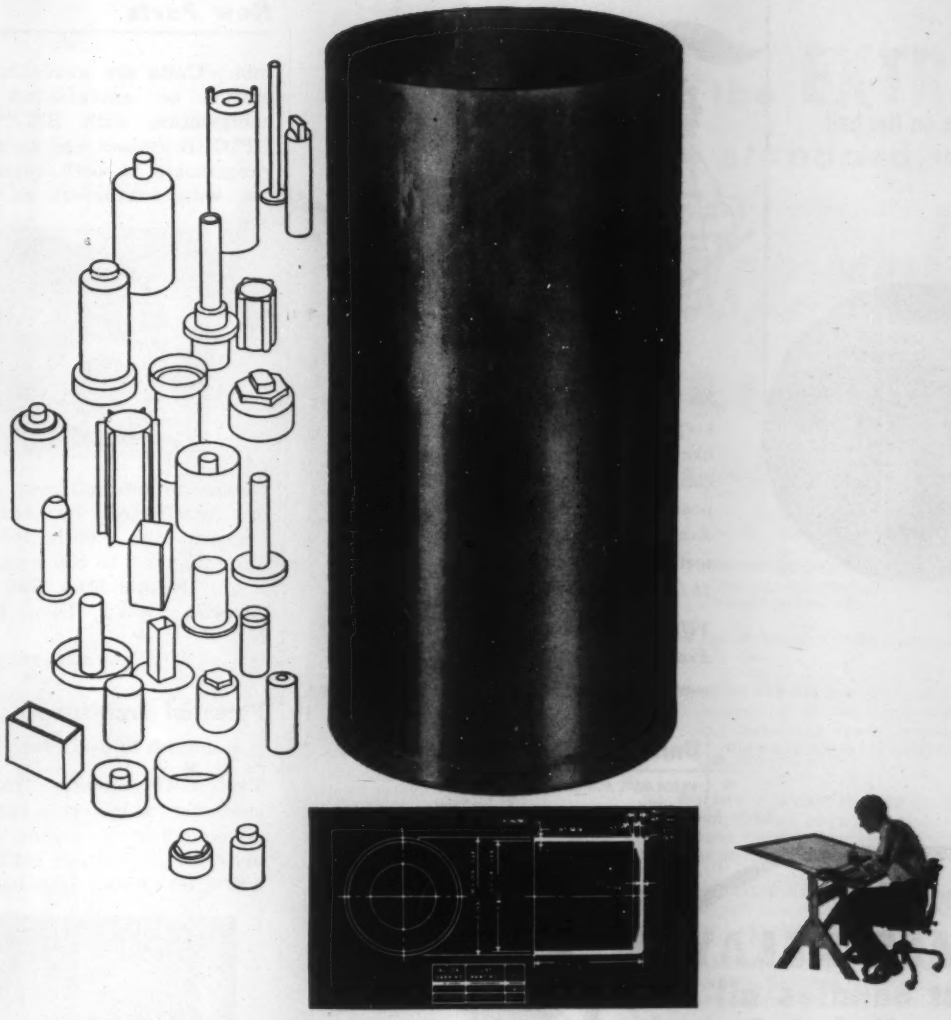
Time-Delay Relay

has octal-plug adapter

Plug-in feature of new time-delay relay adapts the unit to installations using plug-in components. Octal plug is wired internally to the unit, permitting immediate installation and operation. Two timing adjustments are offered, a needle valve and a dial head. Each is adjustable from 0.1 sec to 15



this **ALCOA IMPACT** solved a designer's problem

This large container represents the basic form of impact extrusion. Fabricated in one stroke of the press (as are all impacts), this part looks simple but would present problems if made by any other process. It is noteworthy on at least two counts to designers fighting to reduce material and fabricating costs:

First: it is a chest thumper for the designer who conceived it, because it reduces the cost of the part to one-fourth of the original estimate for other materials and conventional methods of fabrication. Its strong, seamless, easy-to-clean construction fits exactly the requirements for service as a sugar dispenser in an automatic coffee vending machine. *Second:* it is the largest diameter impact we are currently producing and gives you some idea of how big an impact can be. Large or small, simple or intricate, all impacts are completely fabricated in a fraction of a second with just one stroke of the press.

Sound too easy? Well, this is only the beginning. Using exactly the same techniques we can punch round, oval, square or special shapes. We can incorporate ribs, splines, flutes or other functional or decorative longitudinal patterns, on the inside or outside. In fact, just about any closed end tubular part or cup-shaped part should be considered as an Alcoa® Impact. We don't know what we'll be working on next. We'd prefer to be limited only by your imagination.

To get your thinking started, send for Alcoa's design manual, *Alcoa Impacts—Metal in Motion.* For immediate help with any problems, call your Alcoa sales engineer. You'll find the nearest Alcoa sales office listed under "Aluminum" in the Yellow Pages of your phone book. Aluminum Company of America, 1991-L Alcoa Building, Pittsburgh 19, Pa.

Some Impact Rules of Thumb—
Check your problems against this list:

1. Parts requiring hollow sections—either tube or cup-shaped with one end closed.
2. Parts with walls or surfaces requiring zero draft.
3. Parts requiring lengths up to eight or ten times the diameter.
4. Parts requiring the strength of forgings.
5. Parts requiring tolerances down to ±0.005".
6. Parts requiring ribs, bosses or fins as integral parts.
7. Parts requiring low unit cost in mass production. (Often the savings in machining, fabrication and assembly made by impacts amortize tooling in relatively short runs.)

ALCOA ALUMINUM IMPACTS

YOUR GUIDE TO THE BEST IN ALUMINUM VALUE

NEW! "ALCOA THEATRE"
EXCITING ADVENTURE
ALTERNATE MONDAY EVENINGS

Circle 503 on Page 19

Mozart was on the ball

No "square" was Mozart—his compositions keep rolling along through the years like Universal *Precision* Balls—the classically perfect balls with unlimited possibilities for designer and manufacturer. Available in a variety of materials—metallic or non-metallic—with tolerances as fine as 0.000005 of an inch.

YOU are on the ball, too, with Universal Precision Balls.

UNIVERSAL QUALITY CONTROL—FOR ALL AROUND PERFECTION

Universal Ball co.

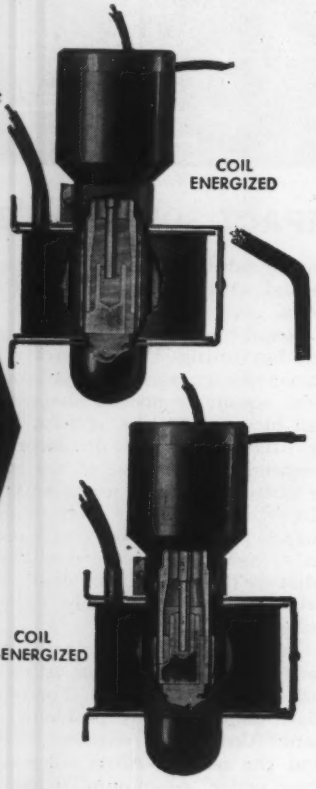
WILLOW GROVE, MONTGOMERY CO., PA.

Circle 504 on Page 19

The
TIMER RELAY
that handles all controlled timing problems . . .

- ★ No false contacts
- ★ Non sticking
- ★ Practically "fail safe"
- ★ Low cost timer

Durakool
STEEL MERCURY TIMERS



This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Combinations of operate-release time delays from 0.15 sec. to 20 sec.—either normally open or normally closed action.

See telephone directory for local distributor, or write.

DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.
700 WESTON RD., TORONTO 9, CANADA

Circle 505 on Page 19

New Parts

min. Units are available for operation on energization or de-energization with SPDTDB and DPDTSB contact and terminal arrangements in both types. For use with continuous ac, or con-

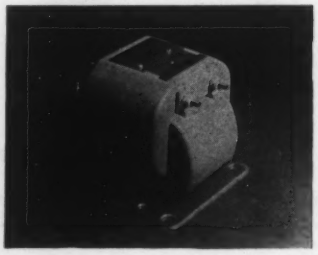
tinuous or intermittment dc, units are unaffected by temperature changes from −65 to 160 F. Voltage range is 6 to 550 v ac, 6 to 230 v dc. **Elastic Stop Nut Corp. of America,** A'G'A Div., Elizabeth, N. J.

Circle 703 on Page 19

Potential Transformer

is molded in polyester

Type EMP potential transformer, available for metering applications, either indoor or outdoor, is molded in polyester. Voltage rating is 480-120 v, 60 cycles. Unit has thermal



capacity of 150 va and operates within 0.3 ASA accuracy class on practically all single-meter installations. **Westinghouse Electric Corp.,** P. O. Box 2099, Pittsburgh 30, Pa.

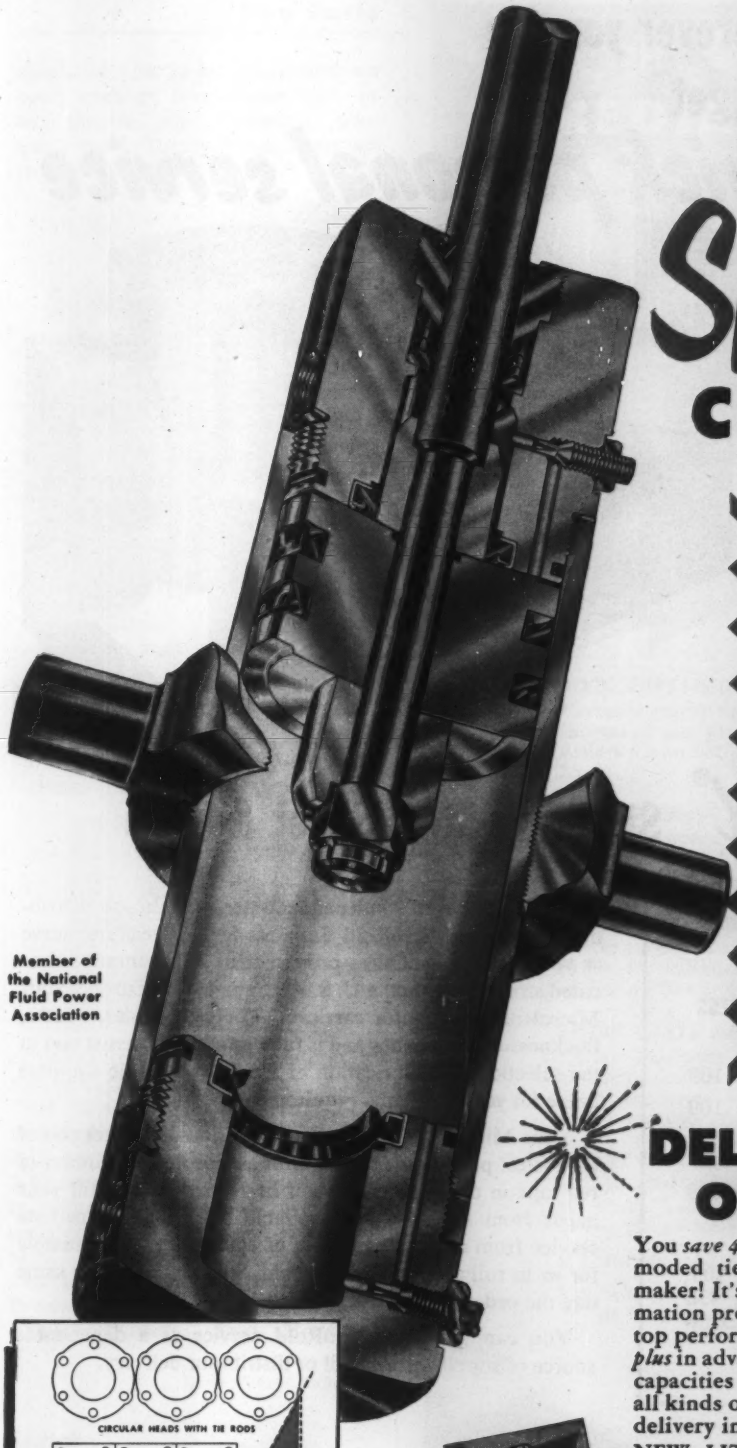
Circle 704 on Page 19

Sediment Strainer

is corrosion-resistant polyvinyl chloride

All-plastic Y-sediment strainer of corrosion-resistant rigid polyvinyl chloride is designed for service with alkalis, acids, inorganic salt solutions and similar corrosive materials. Strainer is rigid PVC

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



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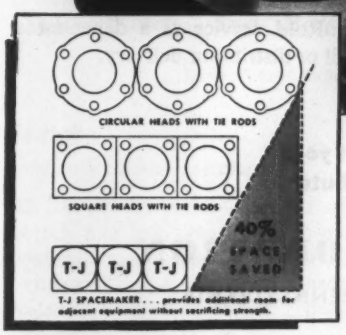
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER**, not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
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T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

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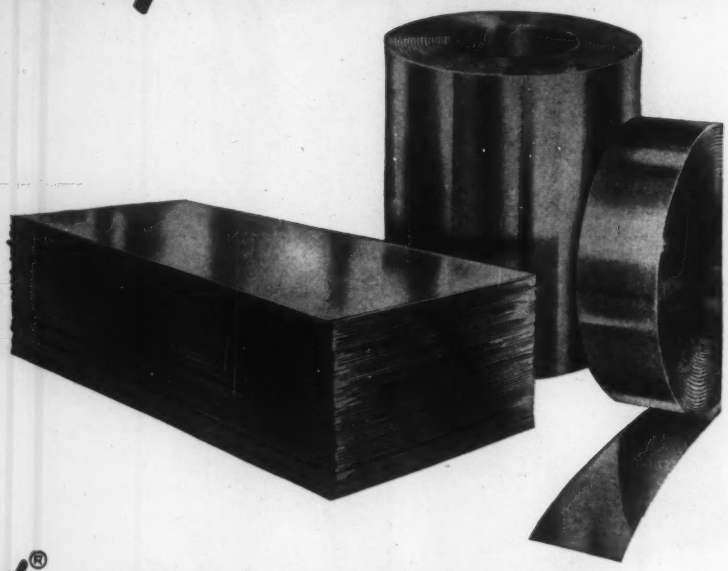

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SPECIFICATIONS

	WIDTH	THICKNESS
SHEETS	up to 36″	.005 to .109
	up to 48″	.010 to .109
STRIP	up to 23 15/16″	.0015 to .009
GRADES:	201, 202, 301, 302, 304, 305, 316, 321, 347, 403, 410, 430 and Micro-Mach (special extra-high-tensile aircraft grade)	

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WASHINGTON STEEL CORPORATION

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sheet with 1/32-in. holes and an open area at least twice that of schedule-80 pipe, assuring adequate flow. Strainer has a service rating of 150 psi at 75 F and 75

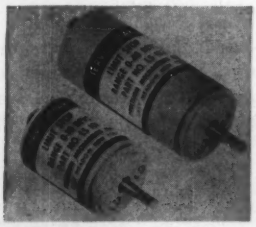
psi at 150 F. Unit is available with threaded, solvent - weld, socket-type, or flanged ends, in five sizes from ½ to 2 in. **Walworth Co.**, 60 E. 42nd St., New York 17, N. Y.

Circle 705 on Page 19

Adjustable Stop

is miniature, multiturn unit

Miniature adjustable limit stop for servo, instrument, and precision-mechanism applications is available with either 0-10 or 0-40 revolutions. A single range-setting



screw at the end cap adjusts stop rotation from zero to full scale. Unit is 0.875 in. diam, synchro mounted; length is 1 5/32 in. for 0-10 turn model and 1⅞ in. for 0-40 turn. Shaft diameter is 0.125 in. Construction is of corrosion-resistant steel and anodized aluminum. Ball bearings are employed and torque capacity is 40 oz-in. **Precision Mechanisms Corp.**, 577 Newbridge Ave., East Meadow, N. Y.

Circle 706 on Page 19

Switch

is roller-lever actuated

BZ-RW922-A2 roller-lever actuated switch has low pretravel, close repeatability and stability, and high overtravel. A 0.25-in. bronze roller is located on top of a double

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ANY BORE SIZE • ANY MOUNT • ANY STROKE

CYLINDERS

AIR OR HYDRAULIC

- **100% EXPANSION OF FACILITIES**
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  Carter cylinders are designed for fast production and immediate off-shelf assembly from standard parts.
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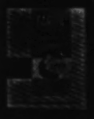
AIR CYLINDERS

250 LB. HYDRAULIC

CLAMP CYLINDERS

1500 LB. HYDRAULIC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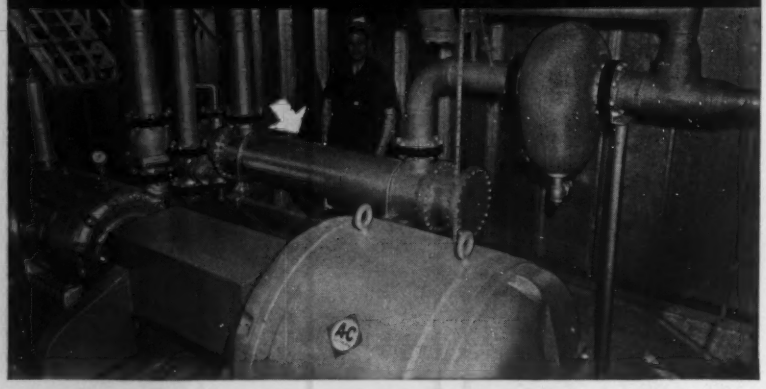
Circle 508 on Page 19

Young cools the gas at this Northern Wisconsin power plant



Superior design and construction make this Young Heat Exchanger first choice for this vital operation

Cooling 1296 C.F.M. of gas from 325°F to 100°F makes exacting demands on equipment. Design and construction features must insure long hours of perfect, unbroken operation, providing maximum cooling with minimum drop in pressure.

On the "Ro-Flo" compressor, a product of Allis-Chalmers, shown in the illustration above, a YOUNG Type "R" Shell and Tube 2-pass Heat Exchanger does the job—and does it well. Tubing is of Admiralty Brass to insure longer life; units of copper, aluminum, stainless steel, etc., are available for special requirements. The special floating head design eliminates expansion strains resulting from fluid temperature differences.

Pre-eminent in the field of heat transfer, years of experience enable Young Radiator Company to reduce "difficult" problems to matters of standard procedure. The accumulated knowledge and experience of our engineers is at your disposal. Consult with our representatives in all principal cities or direct with the home office. There is no obligation.

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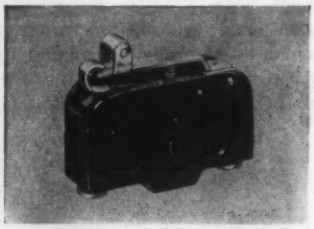
Young RADIATOR COMPANY
RACINE, WISCONSIN
Creative HEAT TRANSFER ENGINEERS
Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

New Parts



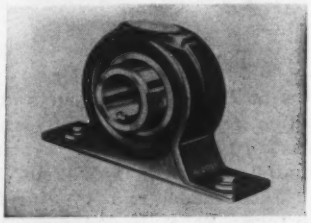
lever arm. As lever is depressed, both levers move downward until switch is actuated. Upper lever then continues downward, providing additional overtravel. Switch can be used with fast-moving cams, and is well adapted for use on control mechanisms such as radar units and precision machine tools. Electrical rating is 125, 250, or 460 v ac at 10 amp. Contact arrangement is single-pole double-throw. **Minneapolis-Honeywell Regulator Co.**, Micro Switch Div., Freeport, Ill.

Circle 707 on Page 19

Bearing Units

provide silent, smooth operation

Zone-hardened, rubber-mounted bearing units provide silent, troublefree operation. Bearings available in pillow block, flange



and cartridge units consist of a ball-bearing unit mounted in an oil-resistant, synthetic rubber ring which fits snugly in a pressed-steel housing. Units are prelubricated and sealed for life. **Stephens-Adamson Mfg. Co.**, Sealmaster Bearing Div., Aurora, Ill.

Circle 708 on Page 19

Adjustable-Speed Drive

packaged units for 3 through 150 hp

Designed for minimum maintenance, this adjustable-speed drive is available in speed ranges of 8:1

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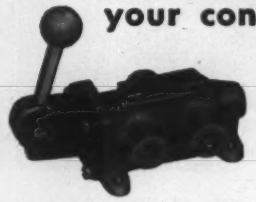
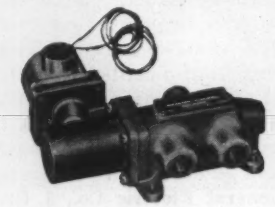


Hand-Operated Four-Way Valve

Foot-Operated Four-Way Valve

Pilot-Operated Valve



Solenoid-Operated Valve

Rotor Type Valve

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Two- and Three-Way Poppet Type Valves with Roller Lever

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LAMINATED SHIM COMPANY, INC.

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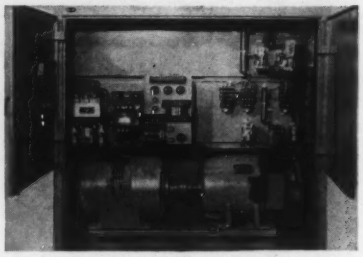
New Parts

and higher. A regulator with silicon rectifiers provides smooth, timed acceleration and deceleration to preset speeds and regulates the voltage. The static excitation system, with a silicon rectifier, has



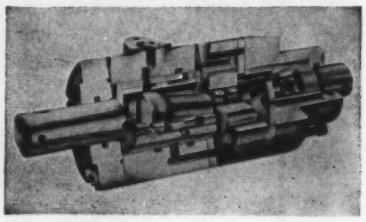
no moving parts and requires no warm-up period. Motor-generator set is a two-unit, four-bearing design, connected by a flexible coupling. Unit-mounted, front-connected, standardized power-unit control devices have recessed wiring troughs to eliminate wiring harness and improve accessibility. **General Electric Co.**, 1 River Rd., Schenectady 5, N. Y.

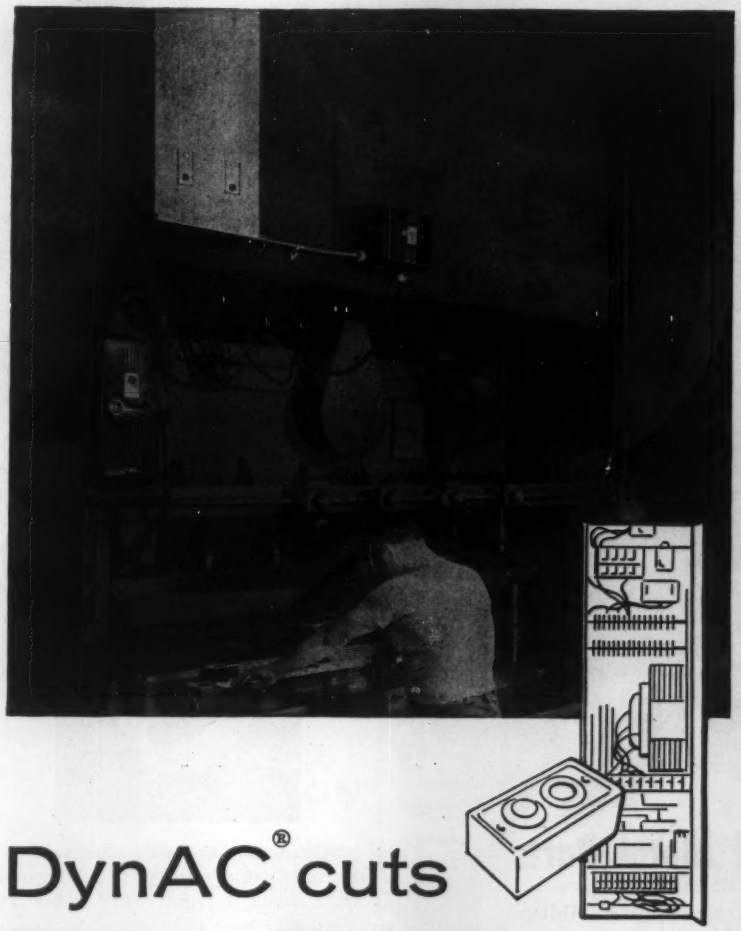
Circle 709 on Page 19

Torque Amplifier

for power steering and other hydraulic applications

Hydraulic torque amplifier is available in two sizes for uses where a rotary control or power shaft requires a power boost. Applications include: Feed controls in machine tools; power steering for trucks, tractors, and lift trucks; actuation of controls for aircraft and guided missiles; operation of large valves; use as a power boost for any rotation shaft. Essentially a servo valve and hydraulic motor, the unit develops much higher torque than would ordinarily be found in a similar size mechanism. IS-103 unit makes available an output torque of 615 lb-in. at 1000 psi. It requires a fluid supply of 3 gpm





DynAC® cuts Press Stopping Time 95%

The eight minutes it previously took to stop the heavy flywheel on this press has been cut to an amazing *24 SECONDS* with Westinghouse DYNAC.

This press is now getting the fastest, smoothest stops possible —increasing production, with no unusual wear.

Because DYNAC is completely electrical, it is simple to install. No costly fittings and troublesome mechanical apparatus. The compact, self-contained unit can be installed anywhere, at machine or for remote operation.

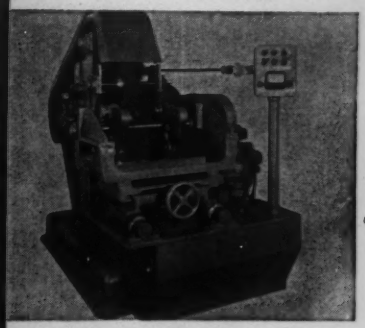
DYNAC is giving fast, smooth moneysaving stops on many applications throughout industry. Call your Westinghouse representative or distributor. Or, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J-22000

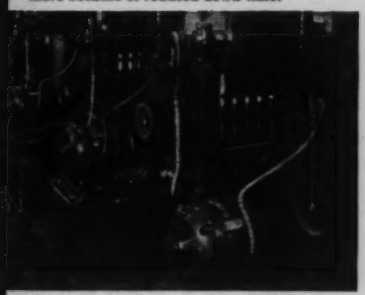
YOU CAN BE SURE...IF IT'S

Westinghouse

HERE ARE SOME TYPICAL APPLICATIONS:



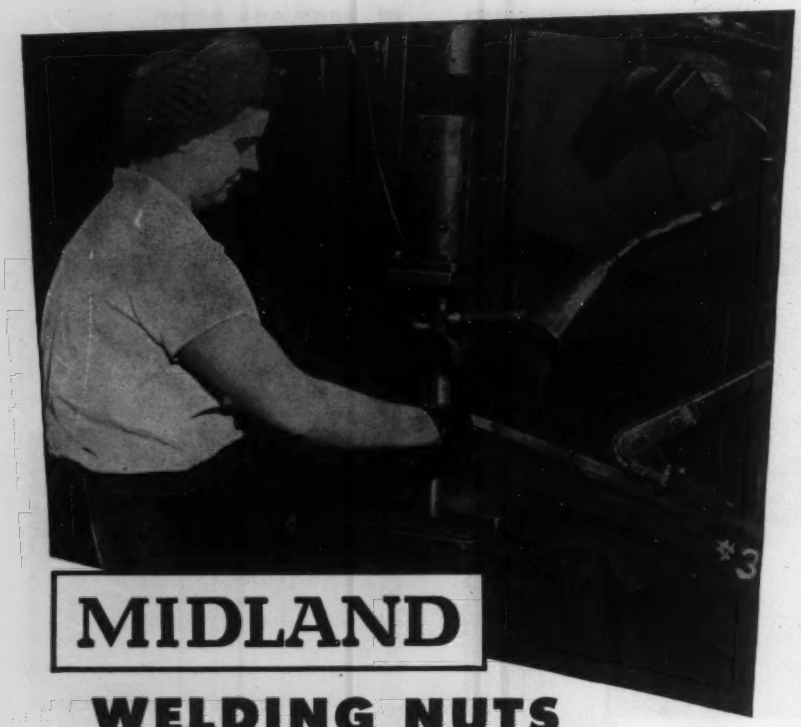
GRINDING MACHINES with DYNAC produce more because of reduced down time.



SPINNING FRAMES with DYNAC have saved owners over $3,000 per year per 100 frames.

CONVEYORS using DYNAC can be stopped once a minute, day in and day out, with no maintenance.

AUTOMATIC WELDERS with DYNAC can complete 600 operations per hour—20 stops per minute—24 hours a day.



MIDLAND

WELDING NUTS

Cut Assembly Time . . .
Insure Proper Fit of Metal Parts

Modern designers of metal parts are finding Midland Welding Nuts a simple, low-cost means of insuring strong, bolted unions at hard-to-get-at places. Once the nut is welded into position at the exact location, the bolt can be easily turned into it without requiring a holding device on the nut. This not only means a saving in assembly time, but often results in one man being able to do a job previously requiring two.

If you're a manufacturer of metal parts, you can enhance your product appeal and at the same time pass along substantial savings to your customers if you use Midland Welding Nuts. By equipping your product with these lock-sure nuts, assembly flows uninterruptedly and parts fit accurately. Welding nuts are applied in a matter of minutes, last the long life of your product.

Inquire about this economical convenience today. You'll find it pays for itself over and over again.

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AUTOMOBILE and TRUCK FRAMES • AIR and VACUUM POWER BRAKES
AIR and ELECTRO-PNEUMATIC DOOR CONTROLS

New Parts

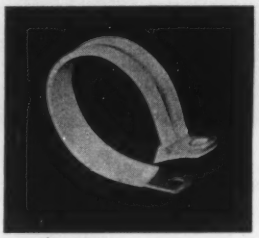
for speed of 100 rpm. IS-104 provides output torque of 1100 lb-in. at 1000 psi. Fluid supply of 3½ gpm provides speed of 80 rpm. **Char-Lynn Co.**, 2843 26th Ave. S., Minneapolis, Minn.

Circle 710 on Page 19

Wire-Harness Clamps

wedge-locked units are cushioned with Teflon

Wedge-locked wire-harness clamps provide short-circuit safety in installations near fuel, gas, inflammable materials, and explosives. They are also suitable for installations subject to spatter or corrosive fluids. Teflon, used as a cushioning material in the clamps, provides low coefficient of friction,



nonflammability, wide chemical resistance, and ability to withstand temperatures from −450 to 500 F. V-shaped wedge, attached to upper foot of clamp, affords a double-sealing action at the tips, preventing wires from being forced out or pinched. Clamps are available in a wide range of sizes and shapes. **TA Mfg. Corp.**, 4607 Alger St., Los Angeles 39, Calif.

Circle 711 on Page 19

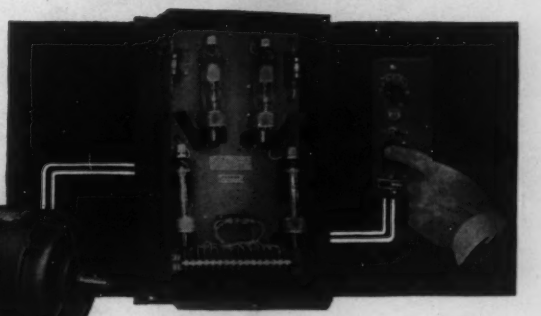
Miniature Switch

has actuation unaffected by high ambient pressures

Actuation of this miniature precision switch remains constant under atmospheric pressures as high as 180 psi. Switch operates equally well in a vacuum. Balancing system automatically equalizes environmental pressures on actuating mechanism, so that actuation force remains constant regardless of surrounding pressure or vacuum. Switches are available with actuation force of either 10 or 32 oz maximum. Applications include refrigeration equip-

New!

RELIANCE V*S Jr.



All Electric
Variable Speed Drive
with Finger-tip Control

The new V*S Jr. gives you instantaneous speed changes, even under load, without belts, pulleys, or gears. This Reliance Drive puts complete machine control at the operator's fingertips. All functions, jog, start, stop, reverse and speed changes are placed in a compact, remote control station.

The 8 to 1 motor speed ratio puts extra flexibility into your machinery. Speeds may be changed through this wide range as frequently as required. The motor will operate through a 100 to 1 speed range for jogging or light intermittent duty.

There's a big power cushion in the motor too . . . power for smooth speed pick up, even under heavy shock loads, and dynamic braking for fast controlled stops without shuddering or jerking.

The Reliance V*S Jr. is your answer to machinery drive problems in the ¾ to 4 horsepower range. Package construction makes installation easy; just plug it in to a single phase 220 or 440 volt a-c. line.

Write for Bulletin D-2505 for complete details. D-1554

RELIANCE ELECTRIC
AND ENGINEERING COMPANY
Dept. 2711A, CLEVELAND 17, OHIO
CANADIAN DIVISION: WELLAND, ONTARIO
Sales Offices and Distributors in principal cities

Circle 514 on Page 19

825-pound Pintle Bushing, for a hydroelectric power project

NBD ...TOPS FOR BIG BRONZE BUSHINGS...

NBD is geared for big stuff like this, or smaller parts, long-run . . . bushings, bearings, gear blanks, pump parts. We cast them in weights up to 20,000 lbs. Machined to any degree of finish, in diameters up to 72 inches. Precise tolerances held to your specifications.

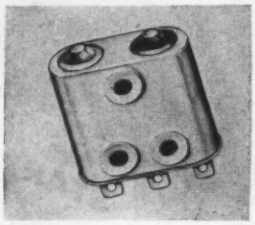
NBD specializes in bronze metallurgy and casting techniques; has developed more than 40 special alloys. Completely equipped for shell mold, cast-to-size and centrifugal casting.

For top quality and know-how in bronze castings, call or write us for quotes or information.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
717 Grant Building • Pittsburgh 19, Pennsylvania
PLANTS IN: CHICAGO • ST. LOUIS • MEADVILLE, PA.

New Parts



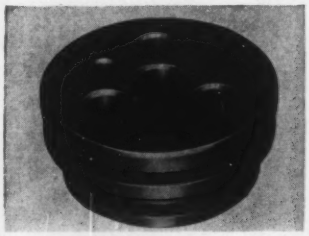
ment, missiles and rockets, aircraft, and petroleum refining. **Haydon Switch Inc.**, 536 S. Leonard St., Waterbury 20, Conn.

Circle 712 on Page 19

Fuel-Pump Bearing

withstands corrosion and high temperatures

This bearing, of self-lubricating, stable Morganite, eliminates failures due to gumming, swelling and warping. Bearing can be used with jet fuels in jet engines, and in almost all other liquids ex-



cept highly oxidizing agents. Material is chemically inert, imparts no taste, odor or colors, and provides excellent operation in the presence of high temperatures and pressures, oil, water, corrosive chemicals and gases. **Morganite Inc.**, Mechanical Carbon Div., 3302 48th Ave., Long Island City 1, N. Y.

Circle 713 on Page 19

Clutches and Clutch Brakes

are reverse-acting, electromagnetic units

Input and output shafts of new reverse-acting, electromagnetic clutches and clutch brakes are coupled when the coil is de-energized. Energization of the coil uncouples the shafts and applies brake to output shaft if brake is required. Operation results in conservation of power in many ap-

Circle 515 on Page 19

NEED A *SPECIAL* RUBBER PART TO LICK A TOUGH PROBLEM?

PHOENIX **4-STEP SERVICE**

assures a better end product

Compounding special rubber to meet specific product requirements has been a Phoenix specialty for over 25 years.

Phoenix 4-Step Service can help you use natural or synthetic rubber in designing a better and often cheaper end product:

We will (1) analyze your problem, (2) assist in designing the rubber component, (3) compound and test the most suitable rubber and (4) manufacture the part with traditional Phoenix craftsmanship.

A Phoenix representative will gladly show you how Phoenix 4-Step Service can help you lick a tough product problem, as it did in case of the flexible coupling below.

THE CASE OF THE FLEXIBLE COUPLING

A flexible coupling component of an automobile window and seat assembly called for rubber bonded to nylon. The problem was to retain this bond under extreme torque running as high as 180°. Additionally, the rubber must not rupture, must be resilient and flexible to all temperatures and be resistant to oil. These characteristics must be retained for the life of the car.

Phoenix compounded a special synthetic rubber with all of the properties required and successfully bonded it to nylon. The component has surpassed all expectations, thanks to Phoenix skills with rubber.

Leading Manufacturers of Custom Molded Mechanical Rubber

PHOENIX

RUBBER PRODUCTS DIVISION

PHOENIX MANUFACTURING COMPANY

JOLIET, ILL. • FOUNDED 1882

Integrated Manufacturing Facilities: RUBBER PRODUCTS DIVISION, OIL AND GREASE SEAL DIVISION, FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION

Circle 516 on Page 19

"Nous Sommes Ici!"

When you need it NOW call Wheelock-Lovejoy!
—for Alloy Steel bars, billets, forgings

Some jobs won't wait for red tape. When you want steel *in a hurry*—just pick up the phone and call your nearest Wheelock, Lovejoy warehouse.

Expert W-L metallurgists will help you choose the right stock for the job.

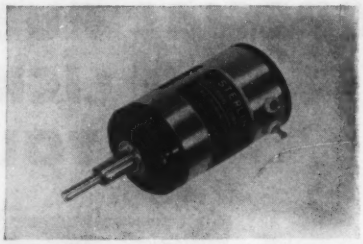
Write our Cambridge office today for your *free* Wheelock, Lovejoy Data Sheets. They'll give you complete technical information on grades, applications, physical properties, tests, heat treating, etc.

Warehouse Service—Cambridge • Cleveland • Chicago Hillside, N. J. • Detroit • Buffalo • Cincinnati • *In Canada*—Sanderson-Newbould, Ltd., Montreal & Toronto.

WHEELOCK, LOVEJOY & COMPANY, INC.

133 Sidney Street, Cambridge 39, Mass.

New Parts



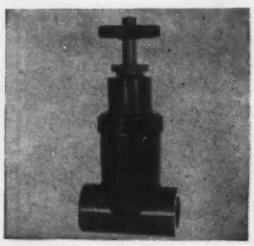
plications. Coupling faces are furnished flat or with crown teeth, resulting in a wide range of torque-transmission abilities. Braking surfaces are flat and are rated at 8 oz-in. minimum torque. **Sterling Precision Corp.**, 34-17 Lawrence St., Flushing 54, N. Y.

Circle 714 on Page 19

Plastic Gate Valve

for corrosive and abrasive liquids

Flex-Plug all-plastic gate valve combines straight-through flow, nonpressure-drop characteristic of a gate valve and throttling, flow-control feature of a globe valve, permitting wide versatility of application. It controls corrosive



and abrasive liquids in lines where chemical contamination must be prevented. Valve is available in 1 and 2-in. sizes with screwed ends. It is offered in both PVC, which resists temperatures to 140 F, and styrene-copolymer, which resists temperatures to 170 F. Valve is rated for 200 psi, and performs well under vacuum service. **Vanton Pump & Equipment Corp.**, 201 Sweetland Ave., Hillside, N. J.

Circle 715 on Page 19

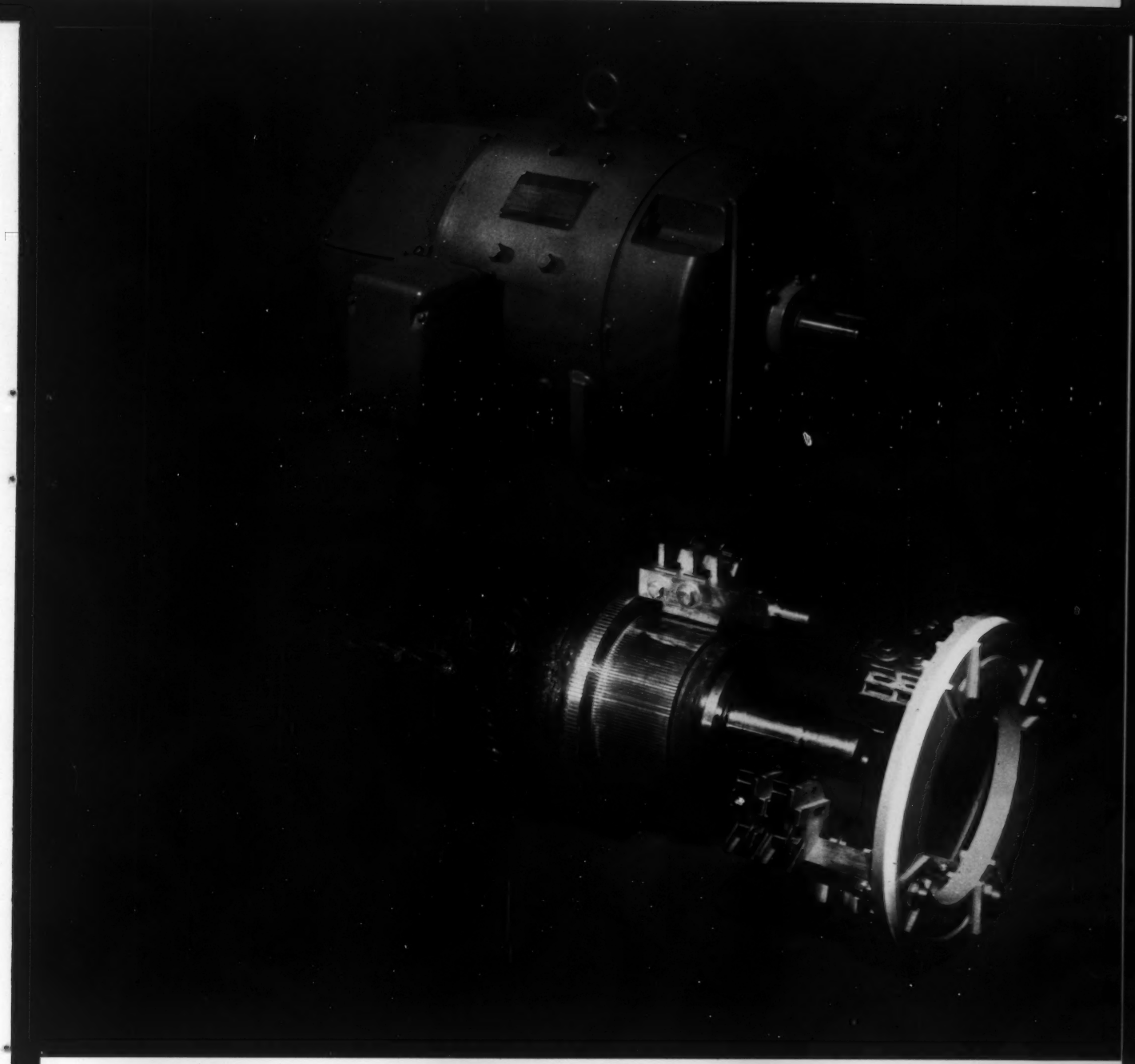
Silencer

for air exhausts

Muffl-Maze, applicable to all types of air and vacuum devices, is a compact, self-contained assembly

Circle 517 on Page 19

Circle 518 on Page 19→



NEW GENERAL ELECTRIC DC MOTOR GIVES

Extra Power To Meet Peak Loads

KINAMATIC* *. . . a new standard in industrial direct-current motors* . . . designed to meet the vital power load requirements of modern manufacturing methods.

Proper Design Balance . . . means unmatched commutating ability . . . the ability to deliver the short bursts of power required for quick acceleration and deceleration. Fewer turns per armature coil . . . full complement of commutating poles . . . maximum number of commutator segments, combine to permit higher peak loads.

New Brush Assembly . . . constant-pressure brush springs eliminate brush adjustments. Bronze, corrosion-resistant brush holders are mounted on square steel studs for stable operation in both directions of rotation. Molded polyester-glass yoke resists impact, intense heat and corrosion.

D-c Kinamatic Motors offer a reliable key to successful automation. Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEA-6355, *Direct Current Motor and Generator Department, Erie, Pennsylvania.*

*Trade-Mark of General Electric Company. 813-11

Progress Is Our Most Important Product

GENERAL ELECTRIC

We own the mint...

ONE DIME

. . . is exactly like the next. But each is a miracle of precision coinage though mass produced.

ONE BEARING

of a given type by MPB is exactly like the next. MPB's coined ball pocket retainers insure precision.

No wonder you find Miniature Precision Bearings the best way to help make your products perform more precisely!

MPB puts the same "coinage" techniques into bearings that make American money the uniformly finest in the world. Each retainer has its own coined ball pockets. Miniature radial retainer ball bearings have smooth, low running torque, even under high thrust loads, because of the unique retainer design. And Miniature Precision Bearings, because they're prelubricated to your specs and individually packaged, assemble in your products so easily that your costs shrink automatically.

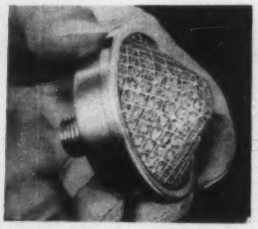
If you've got ideas or problems in miniaturization, remember "we own the mint" on the world's broadest miniature bearing experience. More than 500 types and sizes from $\frac{3}{8}$" O.D. *down* — specials if you require.

Write about your needs and get the new MPB comprehensive catalog. Miniature Precision Bearings, Inc., 111 Precision Park, Keene, N. H.

MPB

MINIATURE PRECISION BEARINGS

Circle 519 on Page 19



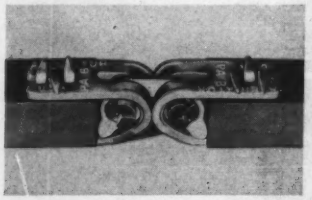
that mounts directly on any discharge port or piping by means of standard pipe thread. By breaking up shock waves created when compressed air exhausts to atmosphere, it attenuates objectionable noise from air exhausts without noticeably impairing efficiency of air-operated equipment. Effective also as an intake silencer, unit can be used on vacuum pumps and small gas engines. Standard sizes are for ⅛, ¼, ⅜, ½, and ¾-in pipe. **Air-Maze Corp.**, 25000 Miles Rd., Cleveland 28, Ohio.

Circle 716 on Page 19

V-Belt Fasteners

for high-speed drives

Alligator aluminum alloy end-plate fasteners reduce whip of high-speed belts, providing longer life for internal working parts. Permanently assembled fasteners



(shown) are applicable when a separable joint is not required. Working parts of the fastener are locked in place by a special forming of end plate. **Flexible Steel Lacing Co.**, 4607 Lexington St., Chicago 44, Ill.

Circle 717 on Page 19

Hydraulic Pump

for large capacity, high-pressure use

Variable delivery hydraulic pump, designated Stratopower 64W1000, permits rotational speeds up to 4500 rpm continuous duty with pump rated 10 gpm at 1500 rpm. Unit has excellent control stabil-

(*Please turn to Page* 216)

DEPENDABLE AIR POWER
CAN IMPROVE THE
Efficiency
OF YOUR PRODUCT

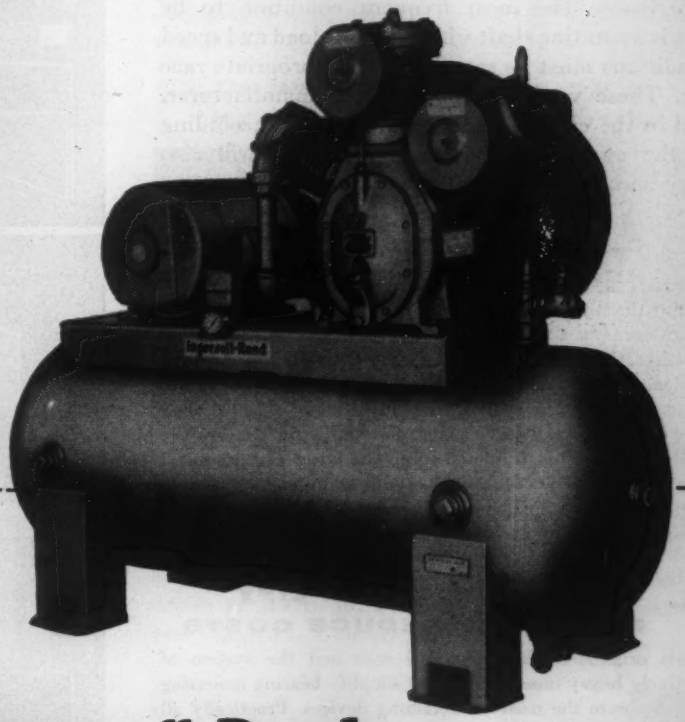
When operation of your equipment hinges on a dependable source of air, get the best compressor. It will add quality and efficiency to your product.

Year after year, since 1878, Ingersoll-Rand air compressors have set new standards of dependable operation through modern design, engineering and production facilities.

Bare, baseplate or receiver mounted air compressors can be supplied to meet your requirements.

Packaged air-cooled compressors—½ through 20 horsepower

Other compressors to 6000 horsepower



Ingersoll-Rand

11 Broadway, New York 4, N.Y.

3-596

Circle 520 on Page 19

Hyatt's Simplified Fitting Practice for Bearing Races

HYATT pioneered the use of carburizing type alloys in order to obtain the advantages of heavier race fits

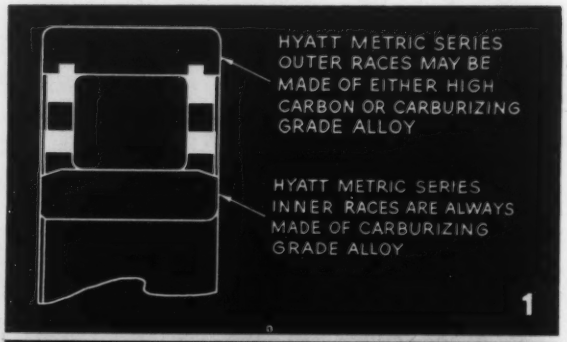
To obtain the best possible performance, roller bearing races must be assembled on shafts and in housings with certain fits developed by design and experience. The most frequent condition to be met is a rotating shaft where specific load and speed conditions must be satisfied with appropriate race fits. These vary according to the manufacturer, and in the case of some manufacturers, according to the application. Naturally, the fits will also vary according to bearing type and size.

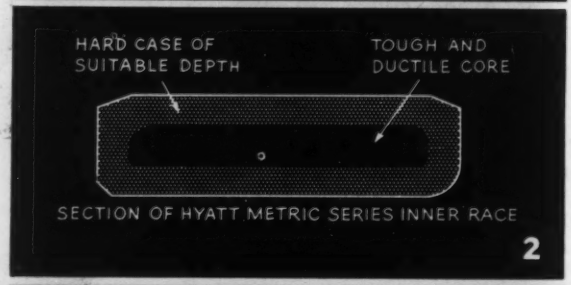
1. CARBURIZING PERMITS HEAVIER INTERFERENCE FITS

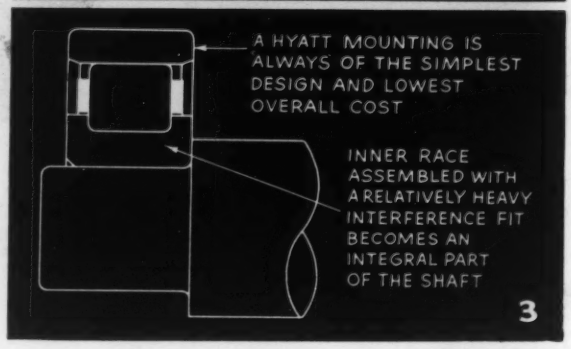
Taking the standard metric series of cylindrical roller bearings for an example, the bearing user has the choice of two fitting practices. One involves the use of inner races made of through-hardening steel, which dictates fairly light interference fits to avoid splitting. The other utilizes races made of low carbon steel *carburized* and hardened to develop a suitable surface hardness and a tough ductile core. The latter permits much heavier interference fits and has the additional advantage of eliminating all auxiliary holding devices, because the race becomes practically an integral part of the shaft. (Figs. 1, 2.)

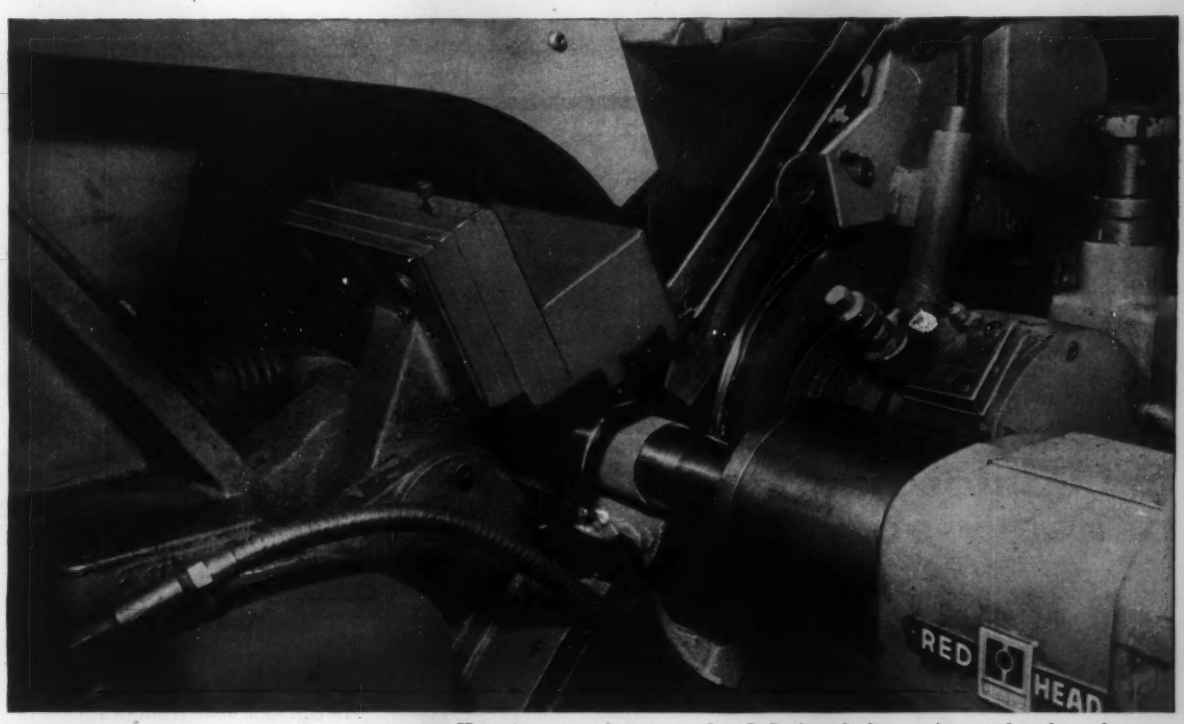
2. HEAVIER FITS SIMPLIFY MOUNTING, REDUCE COSTS

Hyatt originated the carburized race and the system of relatively heavy inner race fits to simplify bearing mounting and eliminate the need for retaining devices. Practically all HYATT inner races are made from nickel alloys of the carburizing type. They permit mountings of the simplest type and lowest over-all cost. Furthermore, the shoulders of HYATT carburized races will withstand considerably greater impact loads than will ordinary races. (Figures 3 and 4.)


HYATT METRIC SERIES OUTER RACES MAY BE MADE OF EITHER HIGH CARBON OR CARBURIZING GRADE ALLOY
HYATT METRIC SERIES INNER RACES ARE ALWAYS MADE OF CARBURIZING GRADE ALLOY
1




A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT
3

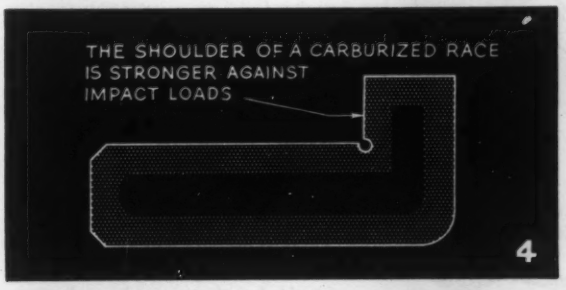


Hyatt inner race being centerless I. D. (inside diameter) ground to close tolerances.

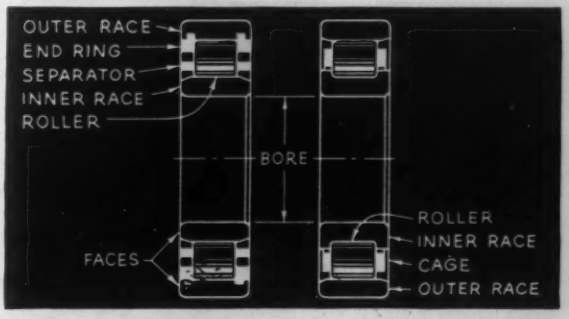
There are two fitting specifications which apply to HYATT inner races, depending on whether the inner race rotates or is stationary in operation. Remember, with both inner and outer race, the rotating member is assembled with heavier fit.

3. HYATT INNER RACES CAN BE EASILY SHRUNK ON SHAFTS

HYATT inner races may be mounted on shafts by pressing or shrinking. Where shrinking practice is employed, first heat the race in oil held at a temperature not over 300°F, or in an electric oven under a similarly controlled temperature, until it expands sufficiently to be slipped into position. The required interference fit will develop as the race cools in place. For special conditions of fit involving hollow shafts of varying sections or multiple housings of dissimilar metals, consult your HYATT Sales Engineer from our nearest sales office.



COMPONENT PARTS OF A HYATT ROLLER BEARING



YOU WILL FIND MORE DETAILS in HYATT Catalog No. 150. If you do not have a copy, write Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. Sales offices at Harrison, Pittsburgh, Chicago, Detroit and Oakland, California.

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

GM GENERAL MOTORS

announcing

A NEW CAMLOC ELECTRONIC CHASSIS LATCH

for easier handling of heavy equipment

- Larger—for easier carrying
- Lighter—to save weight
- Cam operated safety guard against accidental release
- Simplified mounting
- One motion release—lock operation
- Interchangeability permits use of two types of fork assemblies

Camloc's newly-designed Model 27L Electronic Chassis Latch incorporates all the proven features of the 21L which has found wide acceptance since its introduction two years ago...yet offers the added advantages of larger handle size for greater ease in carrying heavy equipment (up to 600 pounds, ultimate load) and is 30% lighter! The 27L also provides cam action for engaging and disengaging multiple contact plugs. Handles are interchangeable with smaller Model 21L, creating a selection of fork assemblies to meet varied requirements. Handle and fork comprise a working unit.

Uses for Camloc Electronic Chassis Latches include airborne radio racks; various electronic equipment; automatic pin spotters; aircraft ground handling equipment; food process machinery.

Complete information is available on request. Ask for Bulletin No. 27L.

"Specialists in fasteners for Industry"

CAMLOC®

FASTENER CORPORATION
37 Spring Valley Road, Paramus, N. J.

WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CALIF.
SOUTH WEST OFFICE: 2509 W. BERRY ST., FORT WORTH, TEXAS

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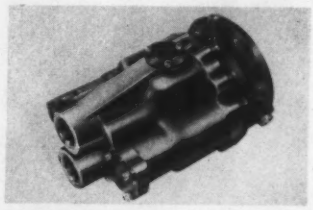
New Parts

(Continued from Page 213)



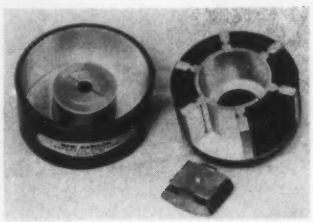
ity, inlet pressurization of under 50 psi at full speed, self-aligning rotating members, and low pulsation and oversurge characteristics. Pump is for aircraft use, including servo applications, when capacities to 30 gpm and pressures to 3000 psi are required. **New York Air Brake Co.,** Watertown Div., Starbuck Ave., Watertown, N. Y.

Circle 718 on Page 19

Coupling

utilizes metallic shoe to conduct heat from drum

Efficient heat transmission in a new coupling eliminates heat checking and reduces drum temperatures. Metallic shoe, which conducts heat away from the drum,



has excellent wearing and frictional characteristics which sustain temperatures in excess of 1000 F with no decrease in torque. Coupling is available with either free or delayed engagement shoes (shown). **O. S. Walker Co. Inc.,** Rawson Coupling Div., Rockdale St., Worcester 6, Mass.

Circle 719 on Page 19

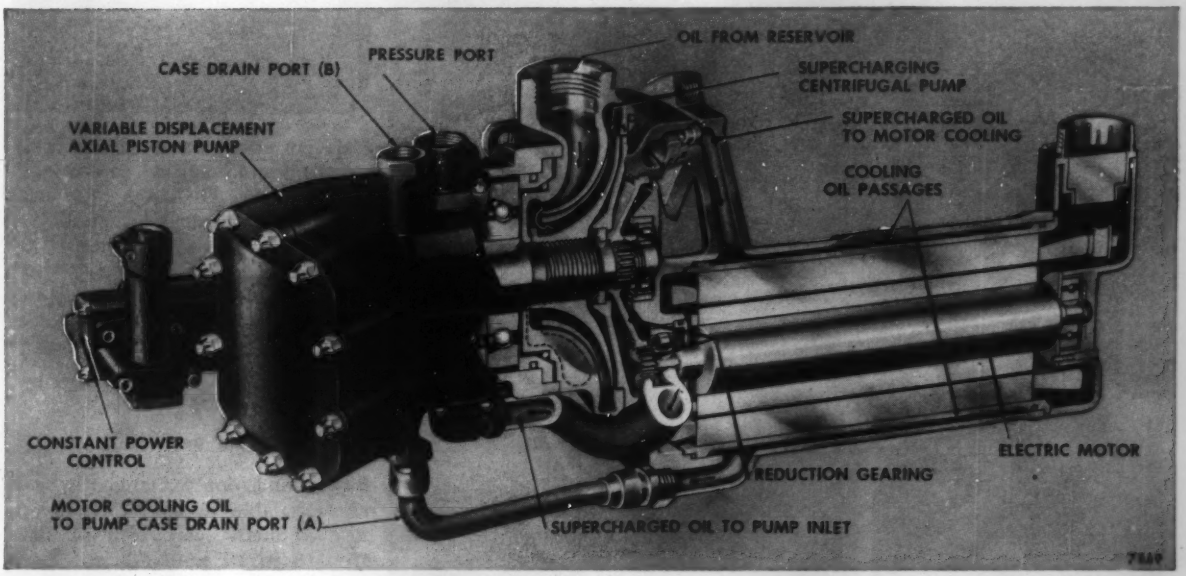
Electrical Contacts

for switches, rheostats, circuit breakers, and contactors

Expanded line of Gibsiloy silver-graphite powdered-metal electrical contacts is fabricated from nine new materials, including silver-graphite, silver-nickel-graphite, silver-tungsten-graphite, and copper-graphite. Use of the new mate-

New Vickers OIL COOLED Motorpump

For Continuous Duty Applications



Installed weight approximately 25% less; also offers significant size reduction

The 12 horsepower oil cooled motorpump shown above weighs 31¼ lb and is 20" long overall . . . motor diameter is less than 4". This represents a substantial saving in weight and size over the conventional air cooled motorpump. Also, there is a further saving with the elimination of duct work in the airframe normally required for air cooling the electric motor. The motorpump illustrated *is now in quantity production* for turbine powered transports.

The time-proven Vickers variable displacement piston type pump, which is an integral part of this "package", delivers up to 8 gpm at 2250 psi, reduces to 6 gpm at 2950 psi and zero flow at 3000 psi. These flow and pressure combinations (8 to 6 gpm range) provide constant horsepower for a variety of flight operating requirements. It is designed for *2000-hour* service.

A centrifugal boost pump is located between the pump and the 400 cycle, 200 v electric motor; in addition to supercharging the pump, it circulates oil through the double-walled motor casing. Cooling oil from the motor jacket is discharged into one case drain port (A) . . . then out port (B) to a heat sink. At full pump flow, the impeller provides 2 gpm to the motor casing.

The 12 horsepower unit described above is typical of the Vickers motor and pump combinations now available to the aircraft industry as "packaged power" for continuous duty applications. Remarkable records for reliability in both military and airline service have been established by Vickers designed motorpumps.

Higher Overall Efficiency

Overall motorpump efficiency (hydraulic power output to electric current input) is 75%. This is possible only because Vickers Piston Pumps have an overall efficiency of 92%. The more efficient pump means the use of a smaller, lighter electric motor, minimum heat transfer to the hydraulic circuit, and less current drain.

Heat Rejection Control

The oil cooled motor design offers a definite advantage in that heat dissipated (140 Btu per minute, maximum) can be conveyed readily to a remotely located heat sink. This is one reason why optimum performance for a given weight and size is more readily achieved in a liquid cooled unit.

High Altitude Operation

Motor operation is not affected by low air density since it is not dependent upon air cooling. Inclusion of centrifugal boost pump prevents piston pump cavitation above 30,000 ft, even though reservoir is vented to atmosphere.

Constant Power Control

The constant horsepower control shown on the above unit is optional, depending on the application. The control maintains constant 3000 psi pressure as flow increases until the electric motor is loaded to its maximum horsepower. Additional flow is then available at reduced pressure to maintain the same horsepower load on the motor. This type of control is particularly advantageous for low force, high capacity (flow) and high force, low capacity applications while staying within the limits of recommended electric motor load ratings.

Packaged Unit

The axial piston pump, centrifugal boost pump, reduction gear and electric motor are all integrated into an exceptionally compact and high-performance package. This concept also permits a high degree of design flexibility to meet individual requirements.

Sound Insulated

Because air ducts are not needed to dissipate motor heat, the oil cooled motorpump can be sealed in a compartment and effectively sound insulated.

Additional Advantages

Low frictional starting torque characteristics of the 12 horsepower unit permit acceleration to maximum speed in less than 200 milliseconds. The electric motor meets the military specifications for explosion-proof operation.

For further information contact the nearest office listed below.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulics Division

Engineering, Sales and Service Offices:

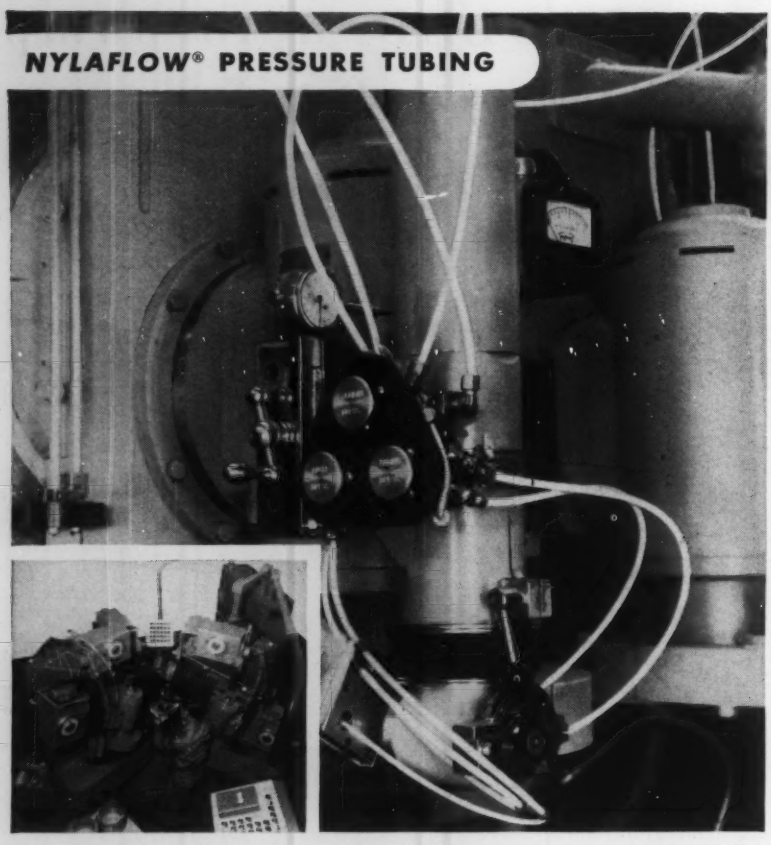
Administrative & Engineering Center
Detroit 32, Michigan

3201 Lomita Blvd.
P.O. Box 2003
Torrance, California

District Sales and Service Offices: Albertson, Long Island, N. Y., 882 Willis Ave. • Arlington, Texas, P. O. Box 213 Seattle 4, Washington, 623 8th Ave. South • Washington 5, D.C., 624-7 Wyatt Bldg. • *Additional Service facilities:* Miami Springs, Florida, 641 De Soto Drive

TELEGRAMS: Vickers WUX Detroit • TELETYPE: "ROY" 1149
CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England



Machine tool designers solve hydraulic tubing problems with flexible *NYLAFLOW*

• Parts and components selected by machine tool builders must meet the strictest specifications and performance requirements. POLYPENCO® Nylaflow Pressure Tubing was chosen for the hydraulic wheel dressers and compensator units of the grinder shown above for these important reasons:

high strength (pressurized at 500 psi) with relatively small size and light weight

retains form—does not sag and foul machine controls

ease of handling

savings in installation

use of standard fittings

• *NYLAFLOW* Pressure Tubing is a tough, flexible polyamide tubing with this unique combination of performance characteristics:

- **High pressure rating at low cost**
- **High resistance to flex and vibrational fatigue**
- **Mechanically strong—resists abrasion and impact**
- **Corrosion and chemical resistance**
- **Serves wide temperature range: as low as −100°F., up to +225°F.**
- **Will not embrittle in storage**

• Available in two short time burst pressure ratings—1000 psi (Type T) and 2500 psi (Type H) O.D. sizes ⅛", 3/16", ¼", 5/16", ⅜".

Information on characteristics, properties, applications, tubing accessories and installation tools is outlined in new NYLAFLOW Bulletin. Write for your copy today.

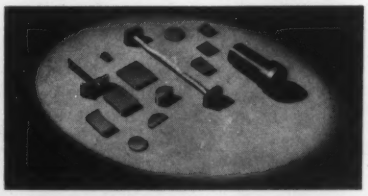
THE POLYMER CORPORATION OF PENNA.
Reading, Pa.
Export: Polypenco, Inc., Reading, Penna., U.S.A.

POLYPENCO

POLYPENCO Nylon, POLYPENCO Teflon†, NYLAFLOW, NYLATRON® GS

†DU PONT TRADEMARK

New Parts



rials permits greater flexibility in selecting and adapting correct contact material to each electrical product. Typical uses include disconnect switches, light-duty air circuit breakers, rheostats, contact brushes, and contactors. **Gibson Electric Co.**, Box 614, Delmont, Pa.

Circle 720 on Page 19

Flanged Wheels

for track-car use

Single and double-flanged wheels are available in semisteel or annealed ductile cast iron in sizes from 5 to 15 in. in diam. Load capacities range from 500 to 6000

lb. Swivel and rigid casters are furnished for mounting wheels, designed for track-car use in plants, mines and quarries. **Hamilton Caster & Mfg. Co.**, 1700 Dixie Highway, Hamilton, Ohio.

Circle 721 on Page 19

Silicone Rubber

for use in − 150 to 500 F temperature range

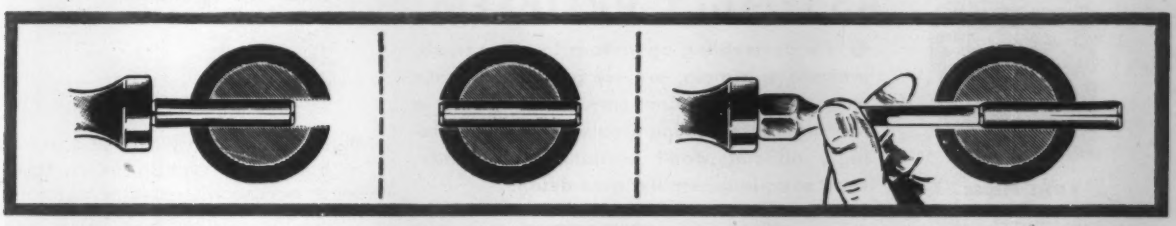
SE-555 is a silicone rubber which possesses high physical strength, low moisture absorption, and good oil resistance. It is especially suited for aircraft seals and gaskets for use in − 150 to 500 F temperature range. Typical physical properties include 1600 psi tensile strength, 650 to 850 per cent elongation, and 200 to 250 lb per in. tear strength. Material can be molded in thick section compo-

what makes this fastener DIFFERENT?

Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces.

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ELASTIC STOP NUT CORPORATION OF AMERICA

R40-114 2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

- ☐ Rollpin Bulletin
- ☐ Elastic Stop nut Bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

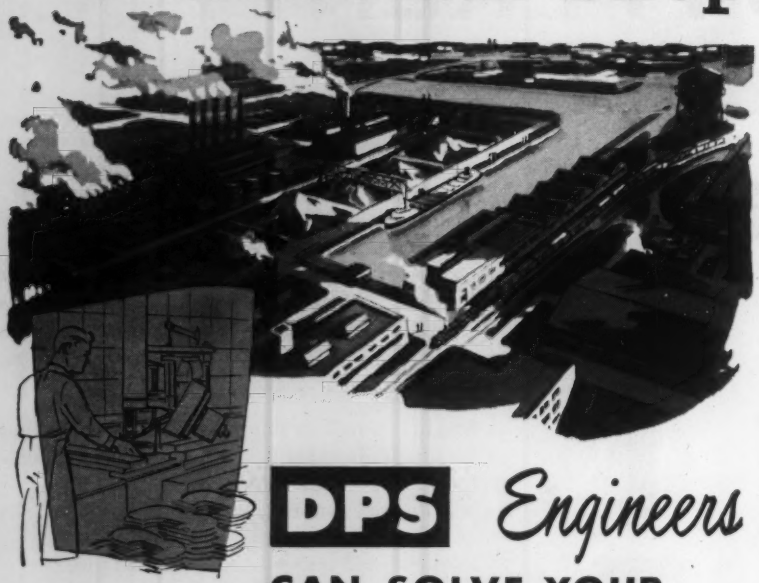
Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

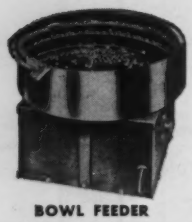
Industrial GIANT or One-Man Shop



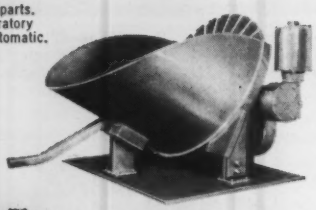
DPS *Engineers*

CAN SOLVE YOUR ASSEMBLY PROBLEM!

● For assembling operations large or small, intricate or simple, we are prepared to take care of your requirements. If you have a feeding or assembling problem, though seemingly difficult, don't hesitate. Write today, send sample assembly, give details.

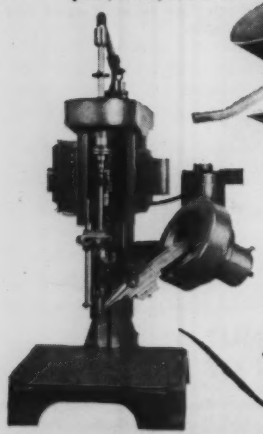


BOWL FEEDER
for light, fragile parts. Operates on vibratory principle. Fully automatic.



DPS
All-Purpose
SELECTIVE PARTS FEEDERS

BARREL FEEDER
with stationary ring cover for heavy-duty production.



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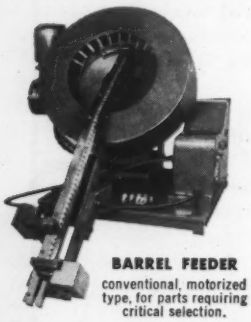
POWER SCREWDRIVERS
5 MACHINES
BENCH & PEDESTAL TYPES



BARREL FEEDER
conventional, motorized type, for parts requiring critical selection.

DETROIT POWER SCREWDRIVER CO.

Write Today for Literature!

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New Parts

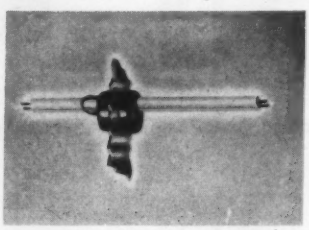
nents or extruded with wall thicknesses of 10 mils and less. Typical applications include boots and bellows, forming blankets, and seals for firewalls, bomb bay doors, wheels and camera wells, hatches, windows, and canopies. Material can be tinted to obtain an unlimited variety of colors, including white. **General Electric Co.,** Silicone Products Dept., Waterford, N. Y.

Circle 722 on Page 19

Strain Relief

for heavy-duty air-conditioning wire

SR-34-1 nylon strain relief is for heavy-duty air-conditioning wire SPT-3, No. 14 and No. 12 gage. Unit is slipped over wire and snapped into chassis hole. It



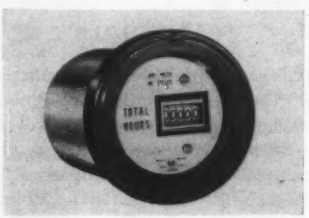
clamps wire firmly and anchors it to housing, preventing wire from being pushed into moving parts or pulled off terminals. Relief fits a $\frac{7}{8}$-in. diam hole. **Heyman Mfg. Co.,** 100 Michigan Ave., Kenilworth, N. J.

Circle 723 on Page 19

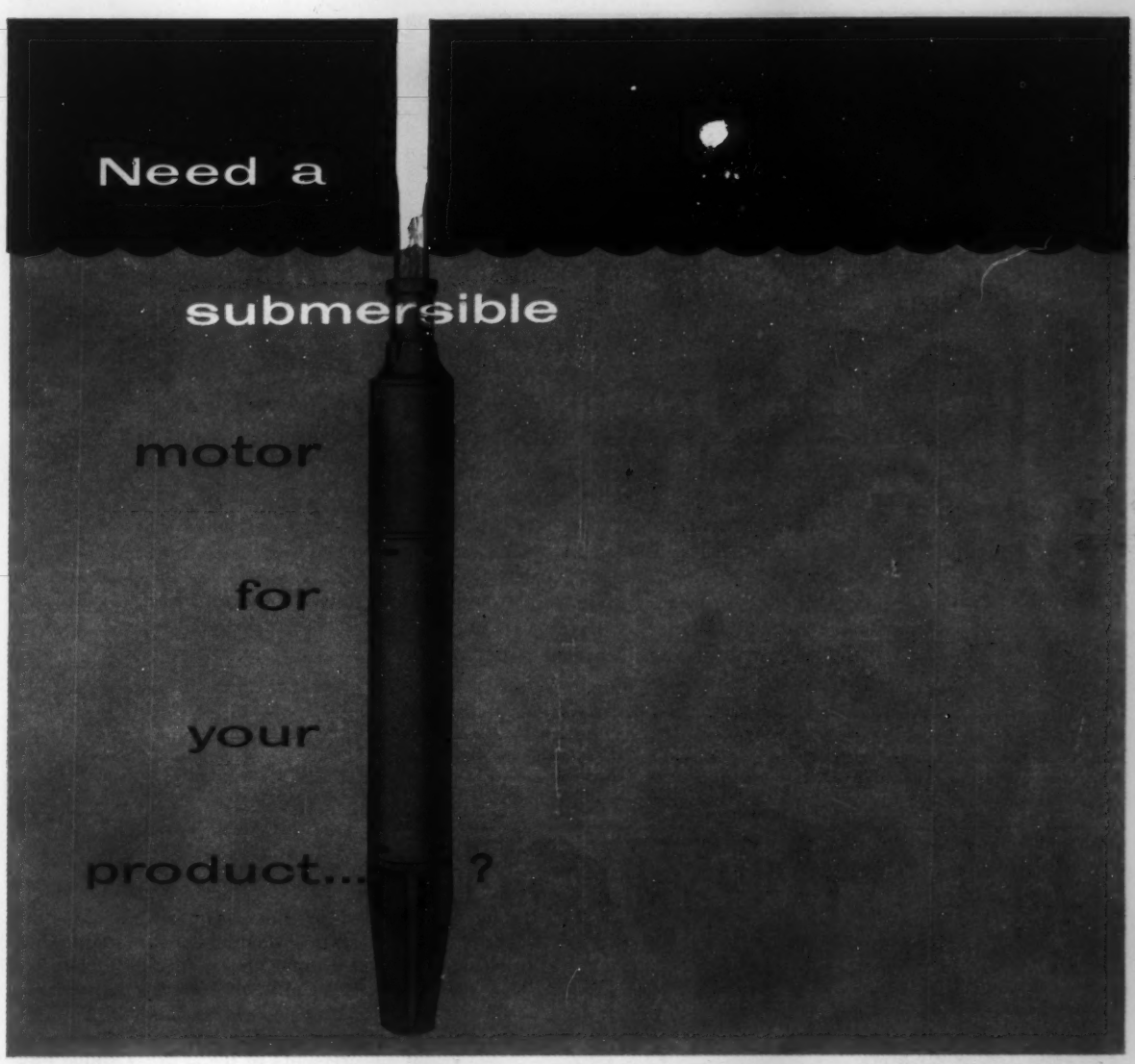
Elapsed-Time Indicator

operates continuously from − 55 to 85 C

This $2\frac{1}{2}$-in. diam sealed elapsed-time indicator is enclosed in a housing which meets military specifications. It has five digit counters that register 1/10-min or 1/10-hr increments to 9,999.9, or hour steps to 99,999. Unit pro-



Circle 526 on Page 19



Confer with J & H motor specialists or write for Bulletin No. 9.1 which gives ratings and performance data: Jack & Heintz, Inc., 17626 Broadway, Cleveland 1, Ohio.

Call Jack & Heintz—America's leading specialist in *Customized* motors, ⅛ to 5 hp (⅓ to 15 hp in submersible models). We'll gladly devote as much time as it takes to design a motor that can operate in water, oil, gasoline and many other fluids. A motor that *electrically*, *mechanically* and *physically* will fit your submersible pump design perfectly.

Customizing electric motors to meet the specific requirements of original equipment manufacturers *is our business*. Because we're organized that way, costs are reasonable to get the submersibility, or torque or envelope you need. We can stretch a motor tall, squat it flat, customize it for ambient temperature rating.

So, go ahead freely! Design your product to do its job. We'll fit a motor to it that will make your product perform the way you want it to . . . look as good as it should . . . last as long as you say it will . . . and sell faster because of it.

JACK & HEINTZ *CUSTOMIZED* ELECTRIC MOTORS

PHILLIPS SUB-MINIATURE RELAYS

Phillips relays are advanced-design subminiatures produced with the meticulous care required for service under severe conditions. Combining dependability, compactness, lightness and ruggedness. Proven by years of application. Write for literature on these and other relays, available in a permanent, three ring binder.

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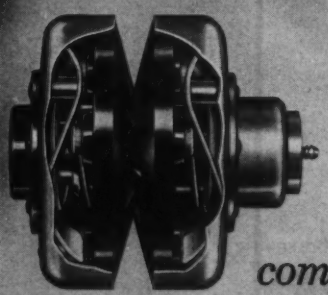
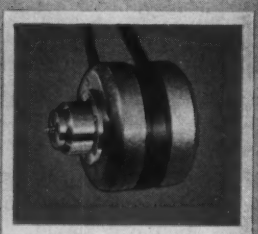
Circle 528 on Page 19

DESIGN-WISE...



this simple pulley solves complicated problems

Compactness of *HI-LO* automatic variable speed pulleys simplifies basic machine design in a vast range of applications. The exclusive design of cam followers on cams provides simple, positive pitch diameter setting control. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt. Belt wear is reduced to a minimum because the belt is never under any more tension than is required by the load. Free technical manuals with diagrams, descriptions of applications and other power transmission data are available from:



Equipment Engineering Company

2855 Columbus Ave., Minneapolis, Minnesota

New Parts

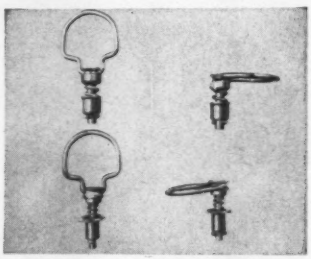
vides a check on operating times of machine tool, electronic, and similar equipment to insure proper maintenance and replacement at desired intervals. Meter has a self-starting synchronous motor for 110-125 v 60 cycle ac, and operates continuously from − 55 to 85 C. **DeJur-Amsco Corp.**, Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 724 on Page 19

Stud Assemblies

bail-handle units are for quarter-turn fasteners

Handle of the 26S22 and 40S47 series studs can be located firmly in vertical, horizontal left, or horizontal right notched position. It cannot be jarred loose by gravity or vibration. Assemblies, designed



to provide quarter-turn quick-operating fastening, are alloy steel with music wire springs. They are cadmium plated in accordance with QQ-P-416a, Class 2, Type II. Stud lengths are available in increments of 0.030 in. **Camloc Fastener Corp.**, 22 Spring Valley Rd., Paramus, N. J.

Circle 725 on Page 19

Flat Borosilicate Glass

resists thermal shock and chemical action

Applications for this glass include gage glasses, oven-door glasses, furnace-sight glasses, cooking sheets, splash plates, heat shields, electronic ovens, or any application where thermal stresses and low corrosion are important. Glass has high resistance to thermal shock and chemical action, and can be used continuously under proper conditions at temperatures approaching 900 F. Glass is highly resistant to corrosive action

Circle 529 on Page 19

Profit-minded fleet operators choose White Trucks equipped with long-lived BLOOD BROTHERS Propeller Shafts

Whatever the job, construction work or highway hauling—profit's the motive. And on White trucks, dependable components like Blood Brothers Propeller Shafts give fleet owners extra profit protection.

At highway speeds, precision balanced Blood Brothers Propeller Shafts deliver maximum torque smoothly—with minimum vibration. On off-the-road jobs, they stand up under the sudden shocks and strains of the most demanding service.

That's why for today's high horsepower engines, White and others depend upon Blood Brothers Propeller Shafts.

If you have a propeller shaft problem, look to Blood Brothers. Our engineering department will be happy to make suggestions.

BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Circle 530 on Page 19

HELP
for engineers!
STANPAT—the remarkable tri-acetate that is pre-printed with your standard and repetitive blueprint items, easily transferred to your tracings by an adhesive back or front. Relieves time-consuming and tedious detail of re-drawing and re-lettering specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections. Saves hundreds of expensive hours of drafting time and money, frees the engineer for concentration on more creative work.
so simple to use:
① PEEL the tri-acetate adhesive from its backing.
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Stanpat Co.

STANPAT CO., Whitestone 57, N. Y., U.S.A.
Send: Flushing 9-1093-1611 Dept. MD 11

☐ Please quote on enclosed samples.
☐ Kindly send me STANPAT literature and samples.

Name_____
Title_____
Company_____
Address_____

Circle 531 on Page 19

New Parts

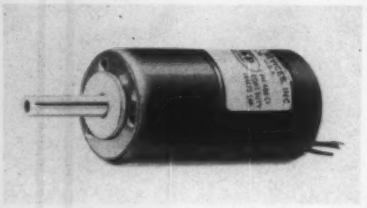
of acids, except for hydrofluoric and raw phosphoric. It offers abrasion resistance approximately three times that of lime glass. **Blue Ridge Glass Corp.**, Kingsport, Tenn.

Circle 726 on Page 19

Miniature Induction Motor

for general-purpose drive-motor applications

A 1-in. diam 60-cycle induction motor operates directly from a 115-v 60-cycle line without the use of step-down transformers or dropping resistors. Available for general-purpose drive-motor applications, it has stall torque of 0.7 oz-in. and running torque of 0.4 oz-in. Unit can drive a 3-in. fan blade at 3200 rpm, or a 4-in. blade at 2700 rpm with only 6 w input. **Eastern Air Devices**, Central Ave., Dover, N. H.

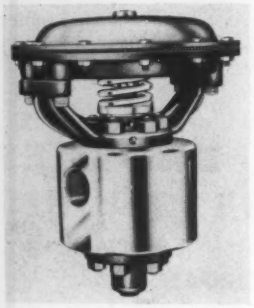


Circle 727 on Page 19

Valves

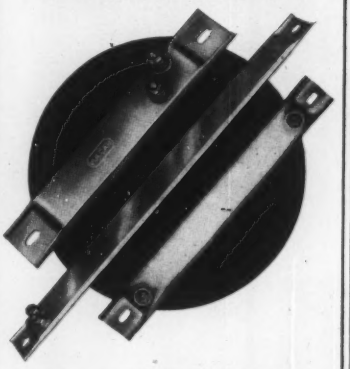
for high-pressure applications

New 6000-lb, two and three-way control valves are for use on plastic molding, ceramic forming, and similar equipment requiring high operating pressures. They provide fast response, leakfree operation, and smooth, shockless opening and closing at maximum rated pressure. Bodies are of solid aluminum-bronze bar stock, which



When to specify

VULCAN ELECTRIC STRIP HEATERS



1. **When application is for:** Contact heating of dies, platens, molds, or any items with flat surfaces to which elements may be clamped. Also air heating source for ovens, air ducts, dryers.
2. **When specifications call for:** Seamless one-piece sheath; rugged non-oxidizing terminal posts; steel sheath for sheath temperatures to 750°F; Chromalloy sheath for sheath temperatures to 1200°F; 8″ to 42½″ lengths (or longer); 150 to 1500 watts (or higher).
3. **When you have "hot" problems:** Vulcan Engineers are ready to supply special heating units — engineered to your needs.

VULCAN ELECTRIC BAND HEATERS

Constructed basically like the strip heaters, Vulcan Electric Band Heaters are designed for clamping around tanks, pipes, injection heads, etc. Standard width is 1½″; inside diameters from 6″ to 15″ (special smaller or larger sizes available). Semi or full circular bands. Equipped with mounting tabs or clamping bands.

Write for free catalog.

VULCAN

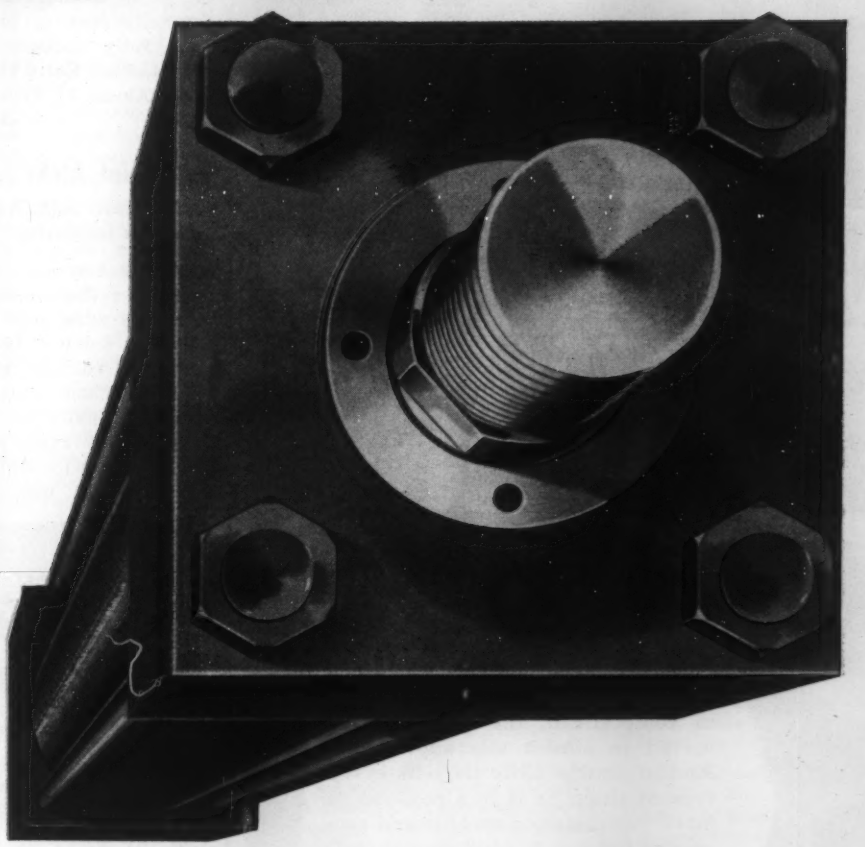
ELECTRIC COMPANY

DANVERS 6, MASS.

Cartridge • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

Circle 532 on Page 19

AT YOUR REQUEST...



ANKER-HOLTH

Hydraulic Cylinders now available in Square Head design

Positive Trouble-free Performance

Anker-Holth Division, for 18 years designers and manufacturers of quality air and hydraulic power cylinders, now offers a standard line of all steel, high pressure square head tie rod cylinders. Important new operating features and design achievements assure positive controlled power for a wide range of industrial applications.

Standardized Mountings for Interchangeability

Conservatively rated at 2000 P. S. I. working pressure and 3000 P. S. I. non-shock pressure every cylinder is proof tested at 4500 P. S. I. All mountings are available, standard bores from 1½ to 8 inches. Standardized mountings provide complete interchangeability with most makes of square head cylinders. The Anker-Holth "□" line meets all J. I. C. specifications.

For more information contact your local Anker-Holth representative or Anker-Holth Division, Port Huron, Michigan. YUkon 5-7181

ANKER-HOLTH DIVISION
THE WELLMAN ENGINEERING COMPANY
2726 CONNOR STREET, PORT HURON, MICH., U. S. A.

Circle 533 on Page 19

MEMO TO H.R.
FROM V.L.
Are we using the field engineer from UNION CHAIN? He can help us.
He certainly can. He represents a company that makes all types of steel drive and conveying chain plus sprockets and attachments. His engineering experience is therefore broad. He is familiar with, or able to comprehend, the problems involved in almost any application. And of course since he sells every type of chain he is in a position to make completely unprejudiced recommendations. A good man to cultivate, the Union Chain man.
TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS
The Union Chain And Manufacturing Company
SANDUSKY, OHIO

New Parts

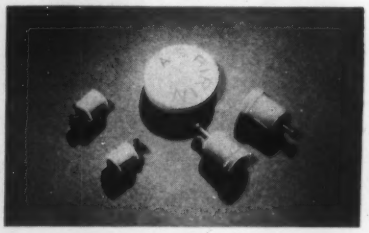
combines toughness with high tensile strength. Valves are available in ½ through 2-in. NPT sizes, normally open or normally closed, with fully balanced stems. **Sinclair-Collins Valve Co.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 728 on Page 19

Test-Point Jacks

miniature units have Teflon insulation

Press-Fit test-joint jacks incorporate beryllium - copper contact members with gold flash over silverplate finish. Teflon insulation provides voltage rating of 750 rms and flashover of 3000 at sea level, or 1300 v at 50,000 ft, in a temperature range from −65 to 200 C. SKT-13, which takes a pin of 0.040 in., measures 0.203 in.



long by 0.140 in. straight-sided bushing diam. SKT-14, taking a pin of 0.060 in., measures 0.345 in. long by 0.148 in. bushing diam. Both sizes are available in eight RETMA code colors. **Sealectro Corp.**, 610 Fayette Ave., Mamaroneck, N. Y.

Circle 729 on Page 19

Trimming Potentiometer

miniature, sealed unit is for critical applications

Aero-Pot G-720 sealed miniature trimming potentiometer withstands severe environmental conditions. Metal body and cover protect against humidity, splashing, and dust. Unit is epoxy sealed around cover and around leads where they emerge from case; silicone O-ring is located behind leadscrew opening. Potentiometer is adjustable through 32 turns by a screwdriver in a slotted shaft, and torque is constant throughout the range. Resistance ranges are from 100 to 100,000 ohms in one case size. Temperature range is − 55 to 175

You Cut Costs with Aeroquip 2802 Hose (Teflon*) Because "*super gem*" Fittings are Reusable!

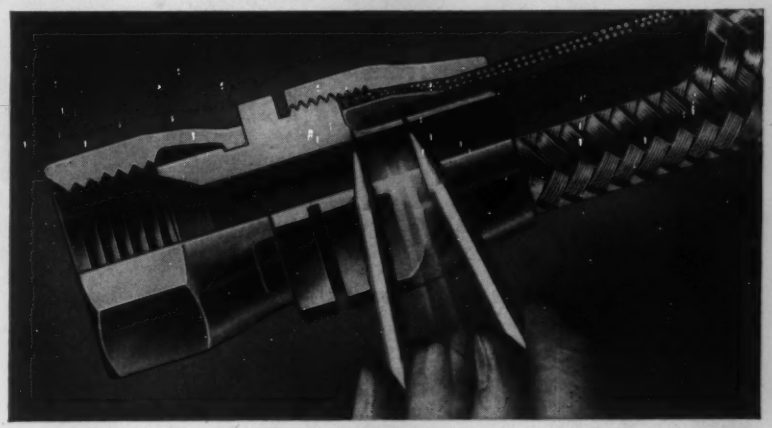
PROLONG LIFE OF FLUID SYSTEMS SUBJECT TO HIGH TEMPERATURES, CORROSIVE CHEMICALS

Hose lines of Teflon give unequalled performance wherever extreme fluid temperatures are encountered, or where chemical stability, lubricity, flexing and long service of the hose are critical factors.

In selecting a hose line of Teflon, important advantages can be gained by giving consideration to the type of fitting used with the hose. For best results, it must be designed to (1) give leakproof performance in prolonged operation and (2) permit disassembly and reuse of the entire fitting.

Only the Aeroquip "super gem" Fitting meets both of these requirements.

The need for a permanently leakproof fitting is obvious in conveying such fluids as live steam and strong acids and bases. How the "*super gem*" Fitting is designed to give double protection against leakage is shown in the illustration at the right.



Cutaway of a "*super gem*" Fitting, with line seal pointed out at left and lip seal at right. Together they furnish permanent protection against leakage. Note how fitting grips only the wire cover, preventing cold flow of the inner tube of Teflon.

REUSABLE FITTINGS CUT COSTS

Due to the relatively higher cost of hose lines of Teflon, the fitting that can be completely salvaged and reused offers substantial savings in cost. The Aeroquip "*super gem*" Fitting can be assembled and disassembled on hose line of Teflon quickly using ordinary bench tools. No expensive swaging machines are required. This permits quick engineering mock-ups and modifications.

In the typical hose assembly of Teflon shown at the left, the fittings account for 54% of the total cost. On the production line or in final use, the entire hose line of Teflon need not be scrapped if an alteration is made involving these fluid lines. In all cases, Aeroquip "*super gem*" Fittings can be disassembled and salvaged completely.

WIDE RANGE OF FITTING SIZES AND MATERIALS

Aeroquip 2802 Hose of Teflon is available in sizes from ¼" to 1". "*super gem*" Fittings are available in aluminum alloy, stainless or carbon steel. Male pipe fittings are available in carbon steel only.

Full information on Aeroquip 2802 Hose of Teflon and reusable "*super gem*" Fittings is available. Fill in and mail the coupon below for engineering bulletin IEB-26A.

Complete engineering assistance is available to manufacturers.

SEE OUR CATALOG PAGES IN SWEET'S PRODUCTS DESIGN FILE, SECTION 6D.

SPECIFICATIONS—AEROQUIP 2802 HOSE

DASH SIZE	—4	—5	—6	—8	—10	—12	—16
O.D. Tube Size	¼	5/16	3/8	½	5/8	¾	1
Hose I.D.	3/16	¼	5/16	13/32	½	5/8	7/8
Hose O.D.	5/16	3/8	7/16	17/32	21/32	25/32	1 1/32
Max. working psi.	2000	2000	1750	1500	1500	1250	1000
Min. burst psi.	12000	10000	9000	8000	7000	6000	4000
Min. bend radii. (ins.)	2	3	4	4 5/8	5 ½	6 ½	8
Wt./ft. (lbs.)	.084	.093	.118	.146	.205	.240	.338

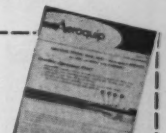
All dimensions in inches.

*DuPont trade name for its tetrafluoroethylene resin.
"*super gem*" is an Aeroquip Trademark.

Aeroquip Corporation
Jackson, Michigan

Please send me the following information on reusable "*super gem*" Fittings and Teflon Hose:

- ☐ Industrial Engineering Bulletin IEB-26A.
- ☐ Aircraft Engineering Bulletin AEB-13.



MD-11

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

INDUSTRIAL DIVISION, VAN WERT, OHIO; WESTERN DIVISION, BURBANK, CALIF.;
MARMAN DIVISION, LOS ANGELES, CALIF.; GENERAL LOGISTICS, PASADENA, CALIF.; AEROQUIP (CANADA) LTD., TORONTO 10, ONTARIO.

Mr. Design Engineer –

Here are BRAND NEW units for improving efficiency of pneumatic operation

— new designs
— new features
— new **HIGH EFFICIENCY**

(introduced by WATTS, leader in flow control specialties since 1875)

Delivers really CLEAN dry air

Watts Filter delivers clean dry air to Federal Products Dimensionair.

High-Efficiency FILTER with exclusive "Tornado Action."

Extreme centrifugal force spirals dirt and moisture particles downward into the "quiet zone" leaving in the air only a minute percentage of the finest and lightest particles which are trapped by the filter cone.

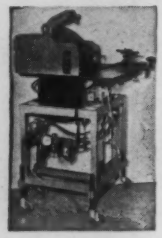
Maintains MORE UNIFORM PRESSURE

Watts Regulator maintains uniform air pressure for Scott-Williams KN Knitting Machine

High-Efficiency REGULATOR with highly sensitive "Aspirator Action."

Watts Aspirator control acts directly on the diaphragm, giving instant compensation for fluctuating pressure demands . . . provides precise control and stabilizes pressures reaching individual pieces of equipment.

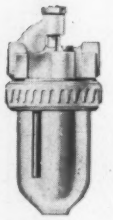
LUBRICATES perfectly at all flow rates



Watts Lubricator provides efficient lubrication for Markem Machine Company's Model 70AF.

High-Efficiency LUBRICATOR with exclusive "By-pass pick-up."

Watts new By-Pass Pick-Up makes possible a sub-miniature, high velocity venturi section which positively creates sufficient force — even at flow rates as low as one cubic foot per minute — to vaporize oil into a fine mist for uniform, economical lubrication.



BEFORE YOU MAKE ANY COMMITMENTS –

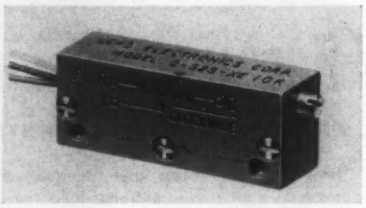
get the facts on Watts new-design units which open up new worlds of efficiency in Pneumatic Operation, Line Maintenance, and Protection of Equipment against foreign matter.

REQUEST CATALOG AND DETAILED SPECIFICATION SHEETS

WATTS REGULATOR COMPANY
SINCE 1875

12 EMBANKMENT ROAD LAWRENCE, MASSACHUSETTS

New Parts



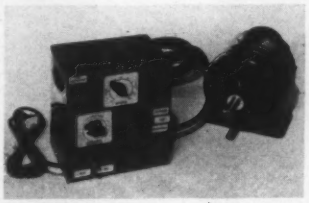
C. Units have Teflon-insulated wire leads or plug-in terminals. **Aero Electronics Corp.**, 2311 W. Burbank Blvd., Burbank, Calif.

Circle 730 on Page 19

Electronic Speed Control

for fractional-horsepower shunt or compound motors

Model SC-¼ electronic motor control provides variable speed from zero to full motor speed at essentially constant torque, forward or reverse. It maintains any desired speed uniformly, regardless of line voltage variations as high as 20 per cent. Control is designed for operation of any shunt or compound dc motor to ¼ hp from a standard 117-v ac power supply. Adjustable dynamic brake provides any desired degree of



braking. Control system is suitable for remote or automatic operation on special applications. **B & B Co.**, 3124 E. 14th St., Oakland, Calif.

Circle 731 on Page 19

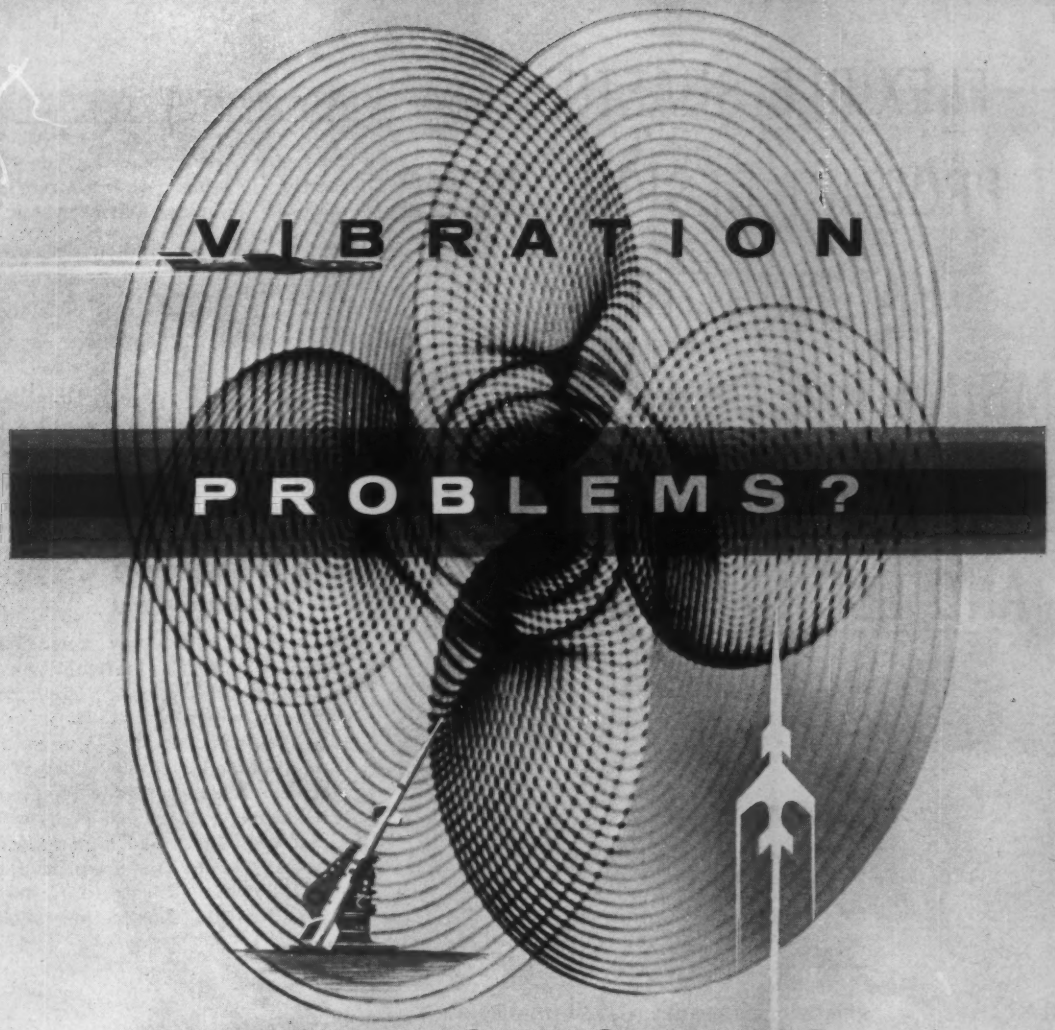
Miniature Battery

has 95-v potential

Dynox 95 battery delivers high current drains for long periods of time. A solid-state, high-voltage unit, it is 1¼ in. long, ⅜ in. in diam, and has a potential of 95 v in 0.14 cu in. It supplies a steady current of 1 x 10^{-9} amp for 176,000 hr at 70 F with 10 per cent voltage drop. Other characteristics include resistance to extreme shock or vibration, and performance at extreme temperature

Circle 536 on Page 19

Circle 537 on Page 19→



CALL OUT CANNON PLUGS

Improvements are constantly being made in Cannon connectors to give you maximum reliability in circuitry under constantly increasing highly critical vibration conditions. New lines... improvements on the AN-E design... include the EX, the CT, the EA, and the EB Series.

You'll find Cannon vibration and moisture-proof resilient-insert lines extensive and complete, in hundreds of carefully designed layouts. Interfacial sealing. Improved grommets and grommet followers. Styles with extra strong coupling nuts. Telescoping rubber bushings. Strong clamps. Means for safety wiring. Grounding lugs. Every facility to give solutions to vibration, moisture condensation, flashover, and corona problems.

Vibration-proof Series include AN-E, CA-AF, CA-F, CA-FN, EA, EB, EX, and CT. Write TODAY for full information.

CA 3101 AF
Pin Assembly

CA 3100 F
Wall Mounting Receptacle

AN 3108 E
63 Inserts Available

CA 3108 AF
90° with Hex Nut

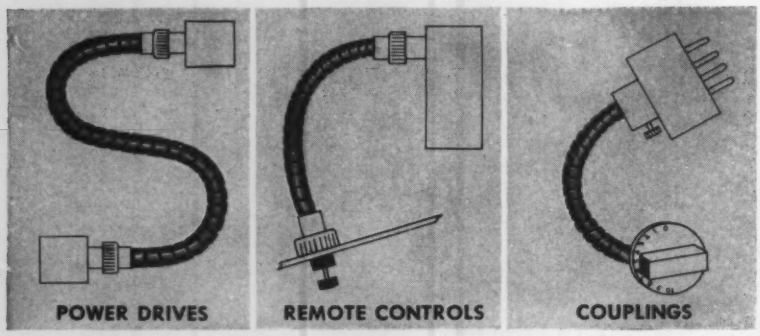
For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

Write for full-page, 2-color Plug Guide, Bulletin CPG-3

Please Refer to Dept. 115

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles, Salem, Mass., Toronto, Melbourne, London. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities.

FLEXIBLE SHAFTS MEET PRODUCT DESIGN NEEDS THAT NO OTHER COMBINATION OF ELEMENTS CAN MEET SO SIMPLY AND ECONOMICALLY!



Lick the problems of designing smaller units . . . simplifying assembly . . . cutting production costs . . . with Robertshaw Flexible Shafting. Eliminates all the restrictions imposed by rigid shafting and connections in transmitting power or control between two points. No alignment problems. Connected members can be positioned for greatest efficiency and space-savings. Weight can be reduced substantially in many units.

Every inch of Robertshaw Flexible Shafting is "custom-made" to your exact needs for aircraft, automotive, appliance, machinery, radio, TV, electronic, portable tool and special applications. Complete engineering help on new or known uses.

Write for Engineering and Design data

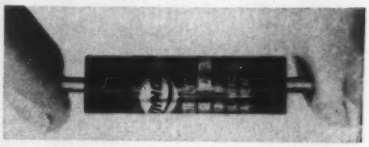
Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

FLEXIBLE SHAFT DIVISION • 110 Summit Ave., Chatham, N. J.

New Parts

ranges. Applications include capacitor charging, power sources in missiles, avionics, alarm systems,



instrumentation, and telemetering. **Universal Winding Co. Inc.**, Patterson, Moos Div., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

Circle 732 on Page 19

Solid Film Lubricant

is corrosion resistant

Designated 66-C, new corrosion-resistant solid film lubricant has a coefficient of friction of less than 0.04, and withstands 1300 hr salt spray test over anodized aluminum. It is an excellent built-in dry film lubricant for operation in temperatures from — 65 to 600 F, as well as for high loads and high speeds. Material meets requirements of MIL-L-25504. **Electrofilm Inc.**, P. O. Box 106, North Hollywood, Calif.

Circle 733 on Page 19

Flow-Control Valve

pressure-compensated unit corrects for flow variations

Pressure-compensated flow-control valve also corrects for flow variations due to fluid temperature changes. Single adjustable throttle is used for all flow rates from 5 to 1000 cu in. per min, and permits a fine flow rate adjustment. Integral check valve permits reverse free flow. Maximum reverse flow is rated at 1400 cu in. per min. Valve is available for either gasket or subplate mounting

Circle 538 on Page 19

Limitless as your imagination...

Rōtac reciprocating torque actuators provide a positive control for any movement from turning watch parts to tipping railroad cars

Just imagine the virtually limitless applications now easily and economically practicable with Ex-Cell-O precision reciprocating torque actuators. Trademarked Rōtac, these actuators transmit maximum torque per displacement in a vast variety of operations: clamping, indexing, lifting, lowering, revolving, pushing, pulling, opening, closing, swinging, oscillating and turning. Into each Rōtac actuator goes the traditional excellence in design, development and manufacture you have come to expect over the years in every Ex-Cell-O-built product.

XLO
EX-CELL-O FOR PRECISION

FREE LITERATURE

If you move *anything*, then you'll want detailed information on Rōtac. Learn how this rotary power is used throughout industry in thousands of applications. Complete with photos, schematics, engineering data, etc.

57-60

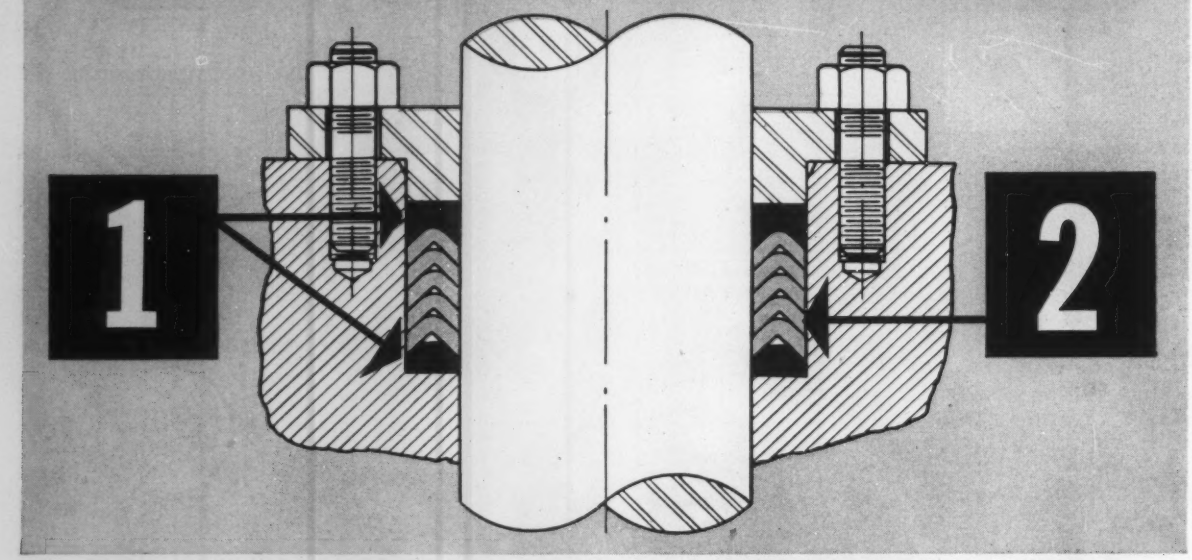
EX-CELL-O CORPORATION

945 E. SATER ST., GREENVILLE, OHIO

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Circle 539 on Page 19

TWO NEW HOUGHTON "V" PACKING DEVELOPMENTS



SAVE TWO GLAND DESIGN JOBS

1

2

Houghton's new molded "V" Packing adapters do away with individually designed metal support rings. And besides saving you design work, they help "V" Packings make a better seal.

These molded rings can "give" under pressure, expanding to bridge the clearance. They'll flex without cracking. They're not subject to the fatigue that can break down metal rings. Because they expand along with packings Houghton Molded "V" Packing adapters provide better support and permit packings to give longer service.

Standard stack heights of Houghton "V" Packings give designers a break, too. When you use Houghton "V's" you don't need to design glands differently because packings of different materials will be used in them. Just figure the number of packings pressure requirements demand . . . then allow for the dimension in your design. Whether you use rubber, fabricated rubber, or leather "V's" . . . they'll fit. They are all the same stack height.

There's more than 50 years of hydraulic know-how behind these new design developments. They're typical of Houghton's complete line of hydraulic and pneumatic packings and hydraulic oils and fluids. For the full story, call your Houghton Man today—or write E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

"V" PACKINGS

. . . products of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

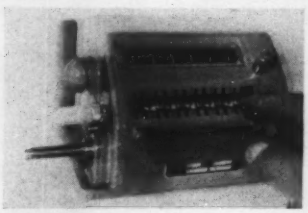
and is interchangeable with older models except that an external drain is not required. **Vickers Inc.**, Detroit 23, Mich.

Circle 734 on Page 19

Counter

adds and subtracts at speeds to 5000 rpm

Model U280-Z counter is designed for controlling processes requiring a warning or deceleration signal. It has two predeterminations, each



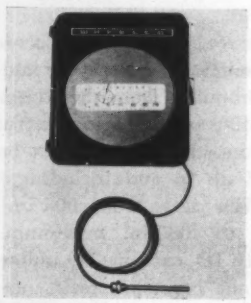
independently settable to a total of 99,999, with knock-off by two spdt switches. Counter adds and subtracts to a maximum speed of 5000 rpm. Double presetting is accomplished by means of grip wheels under hinged cover. Both predeterminations are simultaneously reset to zero for repeat cycling by quick lever or automatically by motor. **Presin Co.**, 12128 W. Pico Blvd., Los Angeles 64, Calif.

Circle 735 on Page 19

Thermometers

for temperatures from −40 to 950 F

New series of thermometers includes recorders, recorder-controllers, indicators, and indicator-controllers. The instruments are avail-



able either as surface or flush-mounted units. Over-all dimensions

(*Please turn to Page* 236)

This relay may look like just another Sigma 11F, but this is not the case. It's the new 11F *with AC adjustment*. As such, it is the only AC relay available in the low price field that can boast such small size and all-around satisfactory performance within its ratings. This is why it sits so smugly at the top of the page, without even a headline.

It should be pointed out here and now that this relay is strictly an *on-off* deal . . . if you're looking for something fancier, Sigma probably has it (at a higher price). But, where you don't need the frills—in such items as water heater controls, tape recorders, and small battery-powered emergency lights used in restaurants, gambling casinos and federal penitentiaries—the 11F-ACS has no peer.

For the less technical-minded (who can't figure out the specs from the comprehensive application data above), the AC 11's have an operating level of 0.3 volt-ampere and will switch one ampere resistive loads at 28 VDC or 120 VAC. They are suitable for applications requiring UL Approval. Size, 1 5/32" square x 1" high, max. Price ranges from about $2.00 to $3.00 list in sample quantities (which *are* available), to about half that in quantities the designers dream about.

Packaging of the Series 11F relays is also an exclusive in the relay field. The relays fit snugly into specially designed molded foam layers which hold 25 or 50 relays apiece and stack neatly (i.e. the bottom of the top layer is the top of the bottom), eliminating the need for individual wrappers, fillers, boxes, bags, etc., and which might simplify inspection and assembly handling. The executives illustrated are *really* contemplating possible end-uses for these white foam layers. Suggestions so far include: raw material for making Christmas decorations, lawn ornaments, backyard toboggan runs, and a replacement for marshmallow fluff in peanut butter sandwiches. Any other constructive suggestions will be welcomed.

Inquiries about the 11F AC relay are also invited.

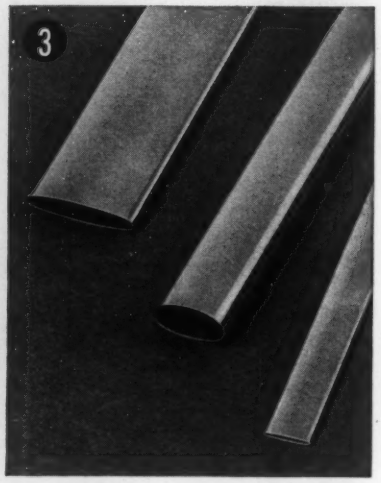
SIGMA

SIGMA INSTRUMENTS, INC., 89 Pearl Street, South Braintree 85, Massachusetts

Circle 541 on Page 19

TUBEXPERIENCE IN ACTION

TO MEET YOUR NEEDS Superior application...UNUSUALLY WIDE



Take advantage of Superior's unequalled variety of instrument tubing. Now you can select tubing from a wide choice of analyses (over 120), sizes, shapes, and mechanical properties. All tubing is produced to extremely close tolerances, finished with bright, clean, uniform surfaces.

1 Mechanical Tubing—Instrument Line

Produced in both seamless and Weldrawn forms, generally to meet such requirements as special OD-ID or ID-wall limits; special analysis or heat selection; controlled mechanical properties; and special finishes. Extra-long straight or coiled lengths or specific cut or multiple lengths. Cut and multiple lengths up to 39 ft. maximum. Coil lengths up to 500 ft., depending on material and size desired.

2 Pressure and Super Pressure Tubing

Made from specially selected raw materials which have had inside surfaces conditioned to remove fissures and other defects. Produced in stainless, carbon and alloy steels to carry pressures as high as 100,000 psi. Finished tubing must meet special inspection standards. Super pressure tubing is available in single wall, which will give long reliable service at lower working pressures, or in composite wall to withstand higher pressures. Used in hydrogenation process equipment and high pressure autoclaves.

3 Bourdon Tubing

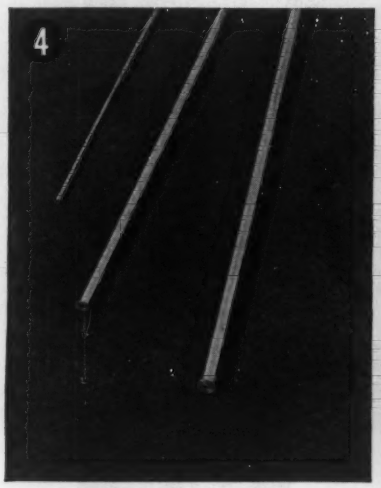
Superior's wide range of alloys and sizes makes it possible to satisfy any set of service conditions—such as high strength, low hysteresis, corrosion resistance, etc.—for Bourdon tubing in indicating and recording instruments. Many different analyses to choose from, including Ni-Span C. Helix and spiral as well as "C" tube elements are fabricated from the many analyses which Superior offers. Smooth, clean surfaces, close dimension control, freedom from decarburization, accurate shaping and cleanliness, all combine to produce Bourdon tubing of unexcelled quality.

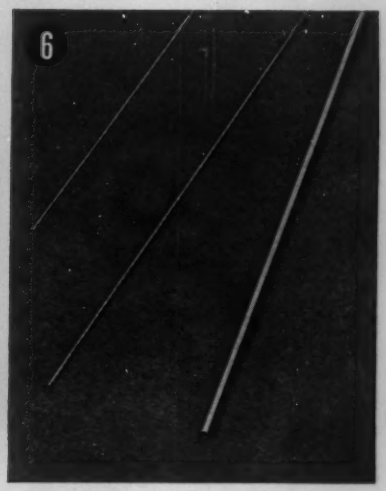
4 Capillary Tubing

Superior capillary tubing is used for transmitting temperature and pressure impulses from the source to a recording or indicating instrument. Any outside diameter can be produced up to and including 3/16 in. OD. IDs range from .004 in. minimum to .080 in. maximum. Has smooth ID, extreme ID uniformity, excellent corrosion resistance, and is easy to weld, braze or solder. Types 304, 316, 321, 347 and 446 stainless, Monel, Inconel, nickel

produces 6 types of tubing for any instrument

RANGE OF SIZES AND ALLOYS





and carbon are recommended analyses. Can be produced in straight lengths or long coils.

5 Large OD Thin Wall Tubing

In sizes to 2½ in. OD, large diameter thin-wall tubing is available in Types 304, 321 and 347 stainless steel. In other stainless analyses the limit is 1⅛ in. OD. It is also available in 16 additional ferrous and nonferrous analyses. Is easily fabricated and has been used in such applications as bellows, flexible metal hose, and instrument casings. Available in both seamless and Weldrawn® (welded and drawn) forms. In a variety of tempers.

6 Needle Tubing

For years Superior has made the finest stainless steel hypodermic needle tubing available. Originally developed to provide free, sterile passage for fluids, this tubing is now used for a wide variety of industrial applications such as tips and fountain parts in continuous inking equipment, nozzles for the application of lubricants, for dispensing minute, accurate quantities of liquids in microchemical work. The high strength, stiffness and strict dimensional tolerances of this tubing make it ideal for instrument application.

Your nearest Superior warehouse distributor can help you with any tubing problems—may often offer money-saving recommendations. If you do not know the name of the Superior warehouse distributor for your area, tell us to furnish you with it.

For a free copy of Bulletin 40—"A Guide to the Selection and Application of Superior Tubing"—write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

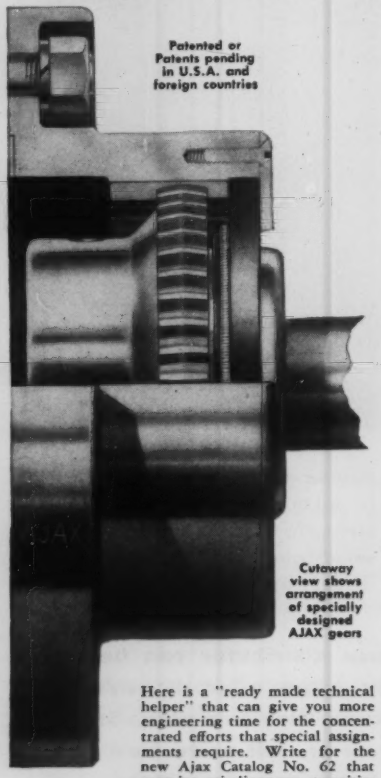
Circle 542 on Page 19

AJAX

Self-aligning

DIHEDRAL COUPLINGS

Short Cut to Major Product Improvement



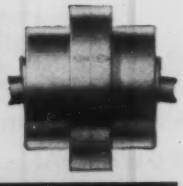
Patented or Patents pending in U.S.A. and foreign countries

Cutaway view shows arrangement of specially designed AJAX gears

Here is a "ready made technical helper" that can give you more engineering time for the concentrated efforts that special assignments require. Write for the new Ajax Catalog No. 62 that contains misalignment capacities of every coupling size and type in the complete line of Ajax Dihedral Couplings. Why spend valuable time duplicating data already established by thousands of proven, field tested applications.

Ajax Dihedral Couplings handle unavoidable shaft misalignment, angular and offset, up to a total of 12°. Teeth can be cut to handle greater misalignment capacities on special order.

Get the facts on how manufacturers of presses, machine tools, rolling mills, cranes, earth moving and many other direct connected machines are simplifying design, cutting manufacturing costs and improving product performance with Ajax Dihedral Couplings.



Write today for your personal copy of Bulletin No. 62.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

Circle 543 on Page 19

New Parts

(*Continued from Page 233*)

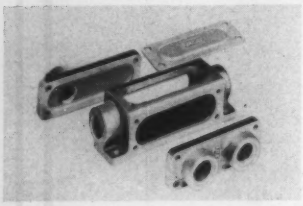
are 16¾ x 14 x 8⅜ in. Temperature range of the series is from −40 to 950 F. **Barber-Colman Co.**, Wheelco Instruments Div., Rockford, Ill.

Circle 736 on Page 19

Conduit Fittings

in five basic body styles

Five body styles and 35 hub covers, with varying hub arrangements, provide approximately 12,000 dif-



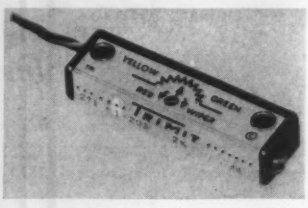
ferent conduit fitting assemblies. Fittings permit complete revision of hub arrangement without dismantling wiring system. Bodies and covers are malleable iron with cadmium-plated finish. Gasketed covers and blind end screws seal out moisture, coolants, and dust. **Ideal-Simplet Fittings Inc.**, 1059 Park Ave., Sycamore, Ill.

Circle 737 on Page 19

Subminiature Potentiometers

for temperatures from − 55 to 85 C

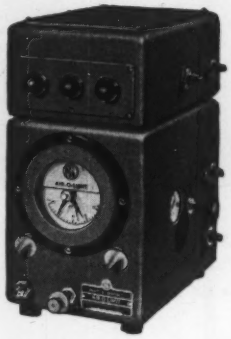
Trimit lead-screw actuated balancing potentiometers have subminiature size, 25-turn, self-locking screwdriver adjustment, and rectangular shape. Applications include communications, measuring and testing, and industrial control equipment, computers, and breadboard mockups. Units are available with flexible leads, solder lugs, or printed-circuit pins. They can be mounted individually or in stacked assemblies, using 2-56 screws through body eyelets. Units have either wirewound resistance



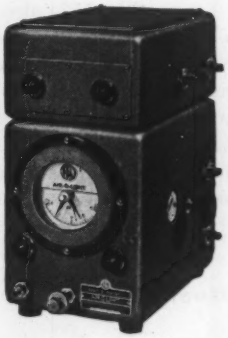
BUILD A GAGE INSTALLATION TO SUIT YOUR NEEDS . . .

with these packaged, on-the-shelf P&W Air-O-Limit Light Signal Units. Can be used to signal operator or to provide feed-back impulse for fully automatic process control.

BASIC 2-LIMIT UNIT . . . indicates high and low tolerances. Suitable for sorting and other "yes-or-no" control applications.

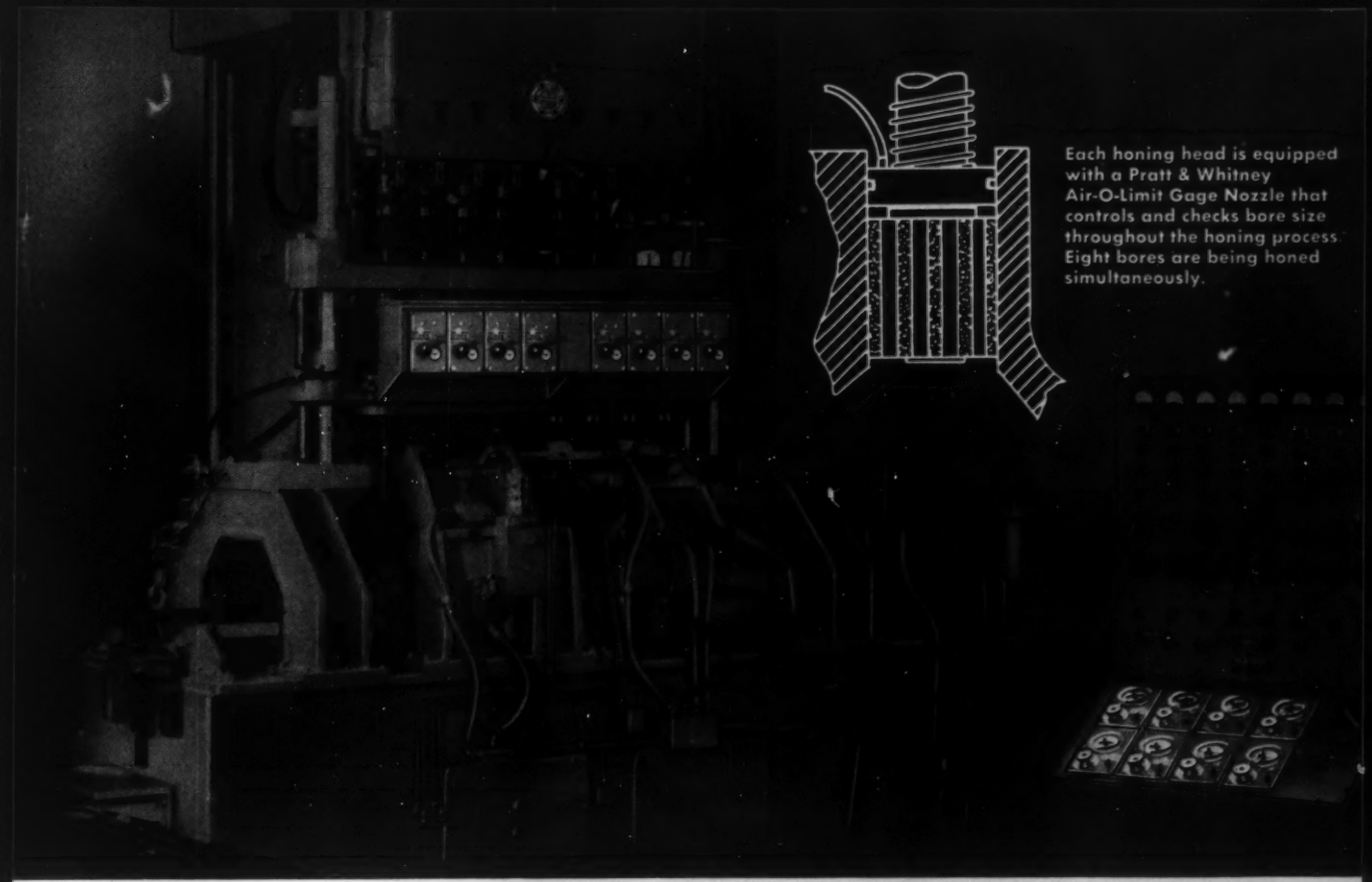


3-LIMIT UNIT . . . especially suited for grinding and similar operations. Indicates or automatically controls such conditions as: "Fast Feed," "Slow Feed," and "Spark-Out."



4-LIMIT UNIT . . . similar to 3-Limit Unit, but provides greater control scope. Indicates or controls such conditions as: "Approach High Limit," "High Limit," "Approach Low Limit" and "Low Limit."

Circle 544 on Page 19



Each honing head is equipped with a Pratt & Whitney Air-O-Limit Gage Nozzle that controls and checks bore size throughout the honing process. Eight bores are being honed simultaneously.

PHOTO COURTESY OF MICROMATIC HONE CORPORATION, DETROIT, MICH.

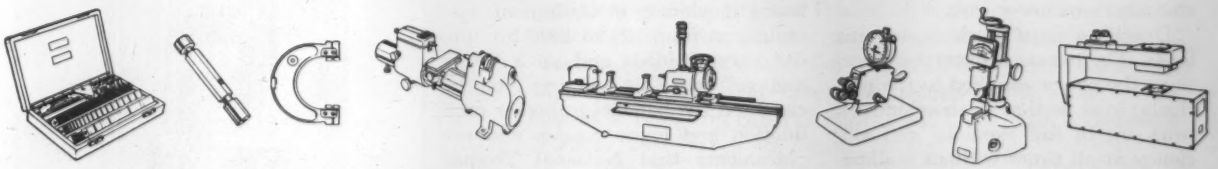
Design Higher Production into Your Machines THE EASY WAY

• • • • WITH PRATT & WHITNEY "PACKAGED" AUTOMATION GAGE UNITS

Pratt & Whitney "Automation Gaging" is fully automatic control of product size by means of "feedback" impulse from automatic gages to the machine. Applied to your designs, Automation Gaging can help you provide performance standards that will increase production rates, reduce scrap losses and take full advantage of the high precision built into your machines. In addition, Pratt & Whitney standard, on-the-shelf Packaged Gage Units provide an installation *custom-tailored* to your design requirements *without* the expense and delays involved in engineering and constructing special controls.

In this example – a Micromatic Hydrohoner – automotive cylinder blocks are gaged *during* the Microhoning process. When final size is reached, the machine is automatically shut off and the Microhoning tools are retracted. A change to a different bore size can be made without stopping the machine, by a simple adjustment on a calibrated gage control dial. Visual indication is given of the accuracy of the new adjustment. Cylinder blocks are produced at a rate of 120 per hour. Reject and scrap losses are virtually eliminated.

Call in a P&W Field Engineer to analyze your requirements and recommend the right P&W Automation Gaging installation to meet your needs exactly. Pratt & Whitney Company, Incorporated, 33 Charter Oak Boulevard, West Hartford, Connecticut.



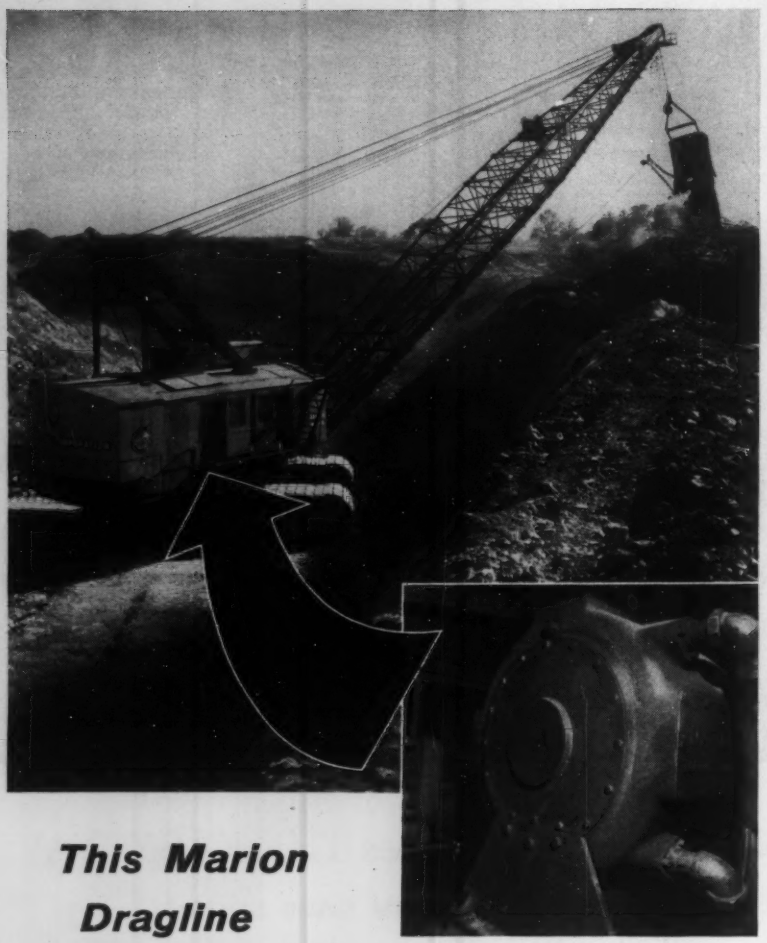
GAGE BLOCKS . . . CONVENTIONAL GAGES . . . SUPERMICROMETERS . . . STANDARD MEASURING MACHINES . . . COMPARATORS . . . AUTOMATION AND CONTINUOUS GAGES

PRATT & WHITNEY

FIRST CHOICE FOR ACCURACY

MACHINE TOOLS • GAGES • CUTTING TOOLS

Circle 544 on Page 19



This Marion Dragline and a National Torque Converter "team up" to speed up this job

Out at the Saxton Coal Corp. in Harrisburg, Illinois, this husky Marion Model 183M Dragline is busy, day after day, stripping away heavy overburden. And because it is equipped with a National Torque Converter, the job gets done faster—smoother—at lower cost.

Draglines must work at varying loads. The torque converter proportions the power supplied to the particular load, so that the machine can work up to full capacity and efficiency at all times without stalling. Furthermore, the converter absorbs shock and strain that would otherwise cause rapid wear and early maintenance.

Even though you may not own or operate draglines, shovels, or cranes, National Torque Converters may be able to save for you. If you have any heavy machinery or equipment, operating at from 100 to 1000 hp, under varying loads and on a "stop and go" cycle, it will pay you to check on the benefits in higher production and lower repairs and replacements that National Torque Converters can bring you. Just write:

THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

Pace-setters in the progress of industrial power transmission

New Parts

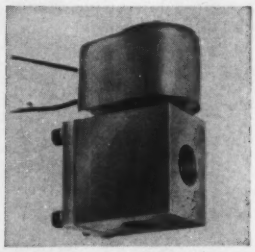
elements from 100 ohms to 10 K, or carbon elements from 20 K to 1 megohm. Operating temperature range is − 55 to 85 C. **Bourns Laboratories Inc.**, 6135 Magnolia Ave., Riverside, Calif.

Circle 738 on Page 19

Solenoid Valve

provides tight shut-off on pressures to 1500 psi

Two-way high-pressure solenoid valve is suited for hydraulic applications, such as hydraulic lifts and elevators. It can be mounted in



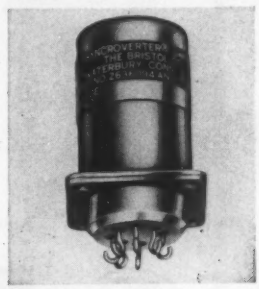
any position without affecting operation. The heavy-duty valve provides tight shut-off on pressures to 1500 psi. Valve is pilot-operated piston type, with angle body. It is furnished in either stainless steel or brass bar stock with Teflon discs and stainless-steel magnetic parts. Valve is available in ½ or ¾-in. pipe connections. **Automatic Switch Co.**, Florham Park, N. J.

Circle 739 on Page 19

Syncroverter Chopper

miniature unit has center-tapped coil

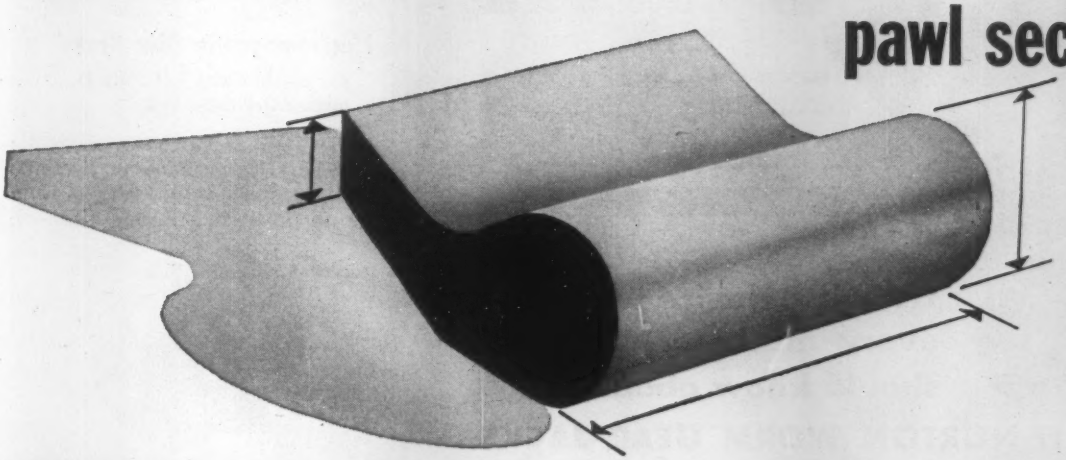
Available for a variety of special driving-circuit applications, this

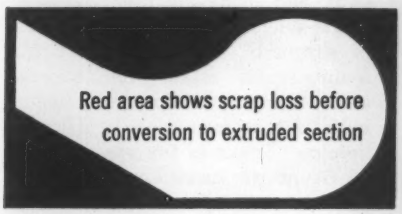


chopper incorporates a center-tapped coil. It can also be used as a polar relay when a biasing voltage is applied, or as a true

52% saving

reported with J&L hot extruded cold drawn pawl section





This pawl was previously milled from a ¾" x 1½" hot rolled oil hardening tool steel. Conversion to a cold drawn extruded section cut cost from 45¢ to 22¢ per part.

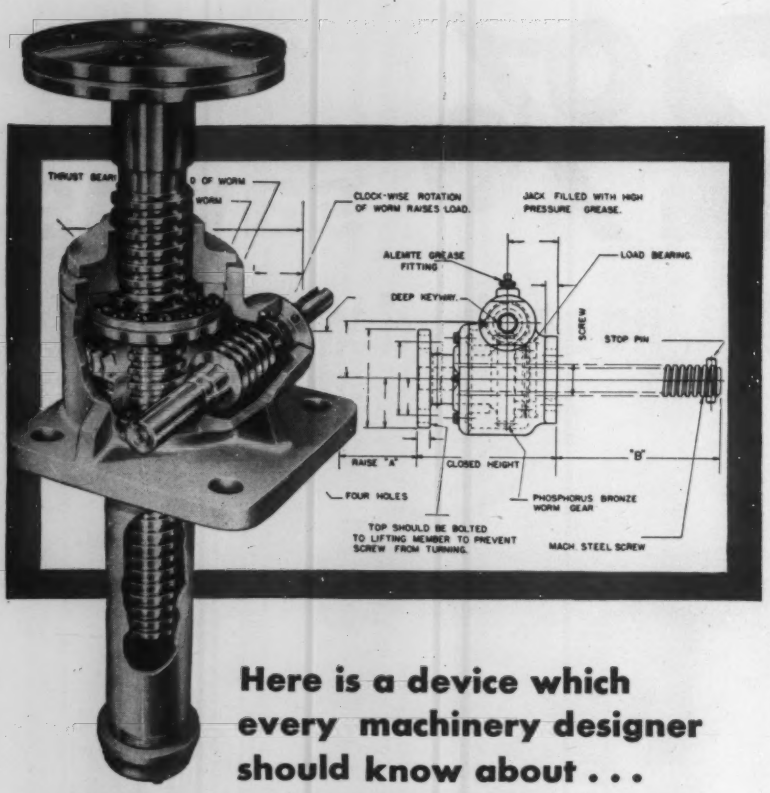
Here's how extruded sections can cut your cost:

1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. Available in a wide range of carbon and alloy steels. For specialty alloy and tool steels, submit inquiry. Get complete details by writing to the Jones & Laughlin Steel Corporation, Dept. 410, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

Jones & Laughlin STEEL ... a great name in steel

Circle 546 on Page 19



Here is a device which every machinery designer should know about . . .

DUFF-NORTON WORM GEAR JACKS

Duff-Norton worm gear jacks provide a purely mechanical means for accurate positioning of loads weighing as much as several hundred tons and maintaining them indefinitely without creep. They will operate in any position, and functioning as components of machinery and equipment they can raise and lower loads, apply pressure or resist impact. Jack capacities range from five to 50 tons. When two or more jacks are connected by means of shafting and mitre gear boxes they lift in unison, even when the load is unevenly distributed. They are available with standard raises up to 25 inches, and will provide exactly the same raise for years without adjustment. Worm gear jacks are suitable for operation at ambient temperatures up to 200°F.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, arbor presses, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting bulletin AD-34-V, which includes drawings and full specifications.

DUFF-NORTON **Duff-Norton Jacks**

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION: Danville, Illinois

Ratchet Jacks, Screw Jacks, Hydraulic Jacks, Special Worm Gear Jacks, Ratchet Hoists, Electric Hoists, Load Binders, Spur Gear Hoists

Circle 547 on Page 19

New Parts

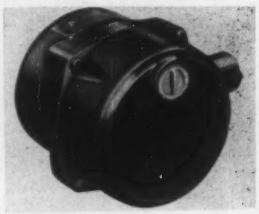
differential relay operating at a given predetermined differential. Ambient temperature range is — 65 to 125 C. Output wave form is unaffected by severe shock and vibration. Two and four-hole flange mounting is available, or unit can be furnished for a standard 7-pin miniature tube socket for plug-in mounting. **Bristol Co.**, Waterbury 20, Conn.

Circle 740 on Page 19

Electromagnetic Disc Brake

for use in Class 1, Group D hazardous locations

Style UH 70 Series electromagnetic disc brake is available in six units with maximum torque ratings from 10 to 75 lb-ft. Brake is short,



light, and easily mounted. It has single-solenoid construction, ease of assembly and disassembly for maintenance, single-point adjustment for lining wear, and visual indication of condition of friction linings. Brake is for use in Class 1, Group D hazardous locations. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

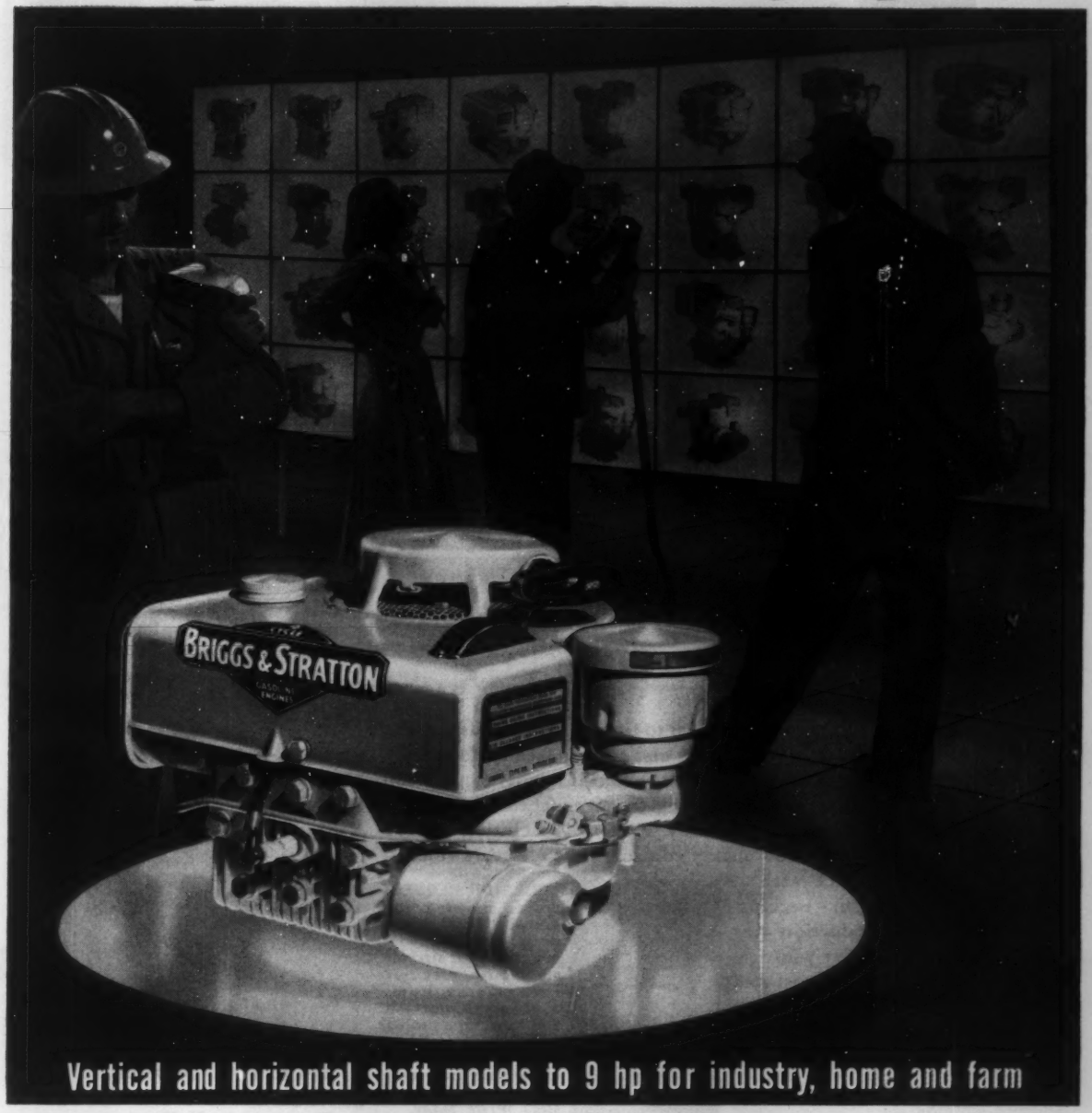
Circle 741 on Page 19

Power Solenoid

has encapsulated coil winding

No. 18 ac solenoid incorporates a coil winding completely encapsulated in thermosetting epoxy, prohibiting penetration by water, extreme humidity, oils, salt air, acid and alkaline solutions, ether, alcohol, hydraulics, and other fluids. Applications include refrigeration and air conditioning, or any equipment which must perform under intense moisture conditions. Solenoid has high dielectric strength, resistance to abrasion and thermal or mechanical shock. Plunger stroke is adjustable from 1/32 to 1 in. Unit is available for intermittent or continuous-duty opera-

Masterpieces in modern 4-cycle power



Vertical and horizontal shaft models to 9 hp for industry, home and farm

Briggs & Stratton 4-CYCLE engines are masterpieces in every respect. Compact, without excess weight, they're built to unequalled standards of quality and precision. They're easy starting . . . thrive on tough going in all kinds of weather to provide top performance for years on end.

Wide choice of models plus Briggs & Stratton's Consulting Engineering Service helps you meet your power needs exactly . . . make great designs and products even better.

But these are only a few of the reasons Briggs & Stratton 4-CYCLE engines are *No. 1 in use throughout the world.* Write for complete story today.

Briggs & Stratton Corp.
Milwaukee 1, Wisconsin

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WHY TRY TO SOLVE YOUR GEAR PROBLEMS ALONE?

PERKINS can custom-cut a precision gear to fit your exact needs... make you a gear that guarantees full capacity and trouble-free performance. Many gear-makers promise a precision gear — Perkins delivers precision . . . always. Fifty-two years of gear-making for aircraft, automotive and instrument manufacturers assure top quality. Extensive facilities, modern equipment, rigid production and quality controls produce gears consistently uniform in tolerance with a burr-free micro finish. Perkins quality eliminates production delays and costly rejects for you . . . Perkins gears wear longer, cost you less in the long run. Ask us to quote on your next gear requirement. Then judge for yourself.

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Folder showing custom gears Perkins has made (from various materials) for aircraft, automotive, precision instruments, home appliances, portable and machine tools, and other products. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

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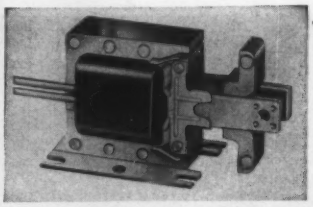
Dept. 33, West Springfield, Mass.
Telephone: REpublic 7-4751

New Parts



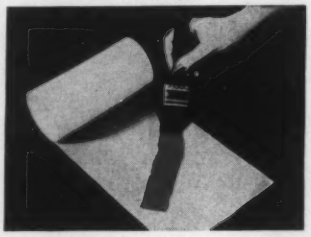
tion. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill.

Circle 742 on Page 19

Bondable Teflon Film

displays nonslip characteristics

Type S clear Teflon film can be completely wetted on one surface, and displays nonslip characteristics. Surface treatment does not involve chemical etching, so that light-transmission qualities are unimpaired. Applications include use as a plastic membrane in evaporator-type solar stills for conversion of saline water, slot liners, and interphase insulation and transformer interlays. Complete bonding to potting resins eliminates voids and hot spots. Film is



available in thicknesses of 1, 2, 3, and 4 mils. Dielectric strength is 3200 v per mil. Tensile strength in machine direction or transverse direction is 4000 psi. **Dilectrix Corp.**, Allen Blvd. & Grand Ave., Farmingdale, N. Y.

Circle 743 on Page 19

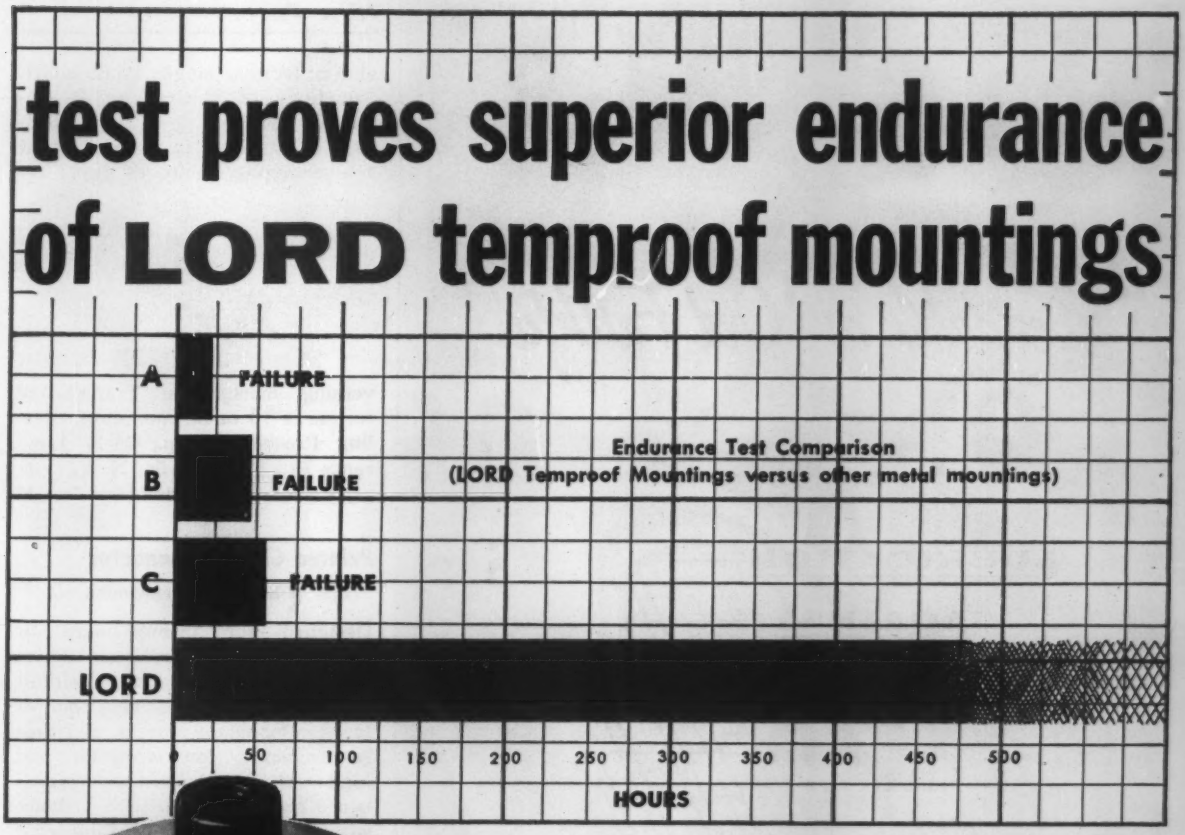
Miniature Clutch

for servo systems and computers

Model T-510 miniature Triplex clutch is an electromechanical unit designed for complex applications in high-accuracy servo systems and computers. Circuit permits engagement or disengagement of either or both output

Circle 549 on Page 19

test proves superior endurance of LORD temproof mountings



LORD TEMPROOF MOUNTING

PURPOSE: To compare the endurance of several commercial vibration isolators used in the aircraft and missile electronics field. Test was conducted by an independent laboratory.

TEST CONDITIONS: Three competitive models, in sets of four mountings each, were placed under loads of 16 pounds and vibrated simultaneously at frequencies from 5 cps to 44 cps at a double amplitude of .060".

RESULTS: At the conclusion of the test only the LORD Temproof Mountings had functioned 425 hours and were still in service—with no significant change in vibration characteristics. Mounting "A" failed in less than 20 hours . . . mountings "B" and "C" failed in less than 60 hours.

CONCLUSION: "The LORD Temproof Mounting is more durable than the other vibration isolators tested."

Why handicap fine equipment with vibration isolators that provide less than the best performance? For further information, contact your nearest LORD Field Engineer, or the Home Office, Erie, Pa.

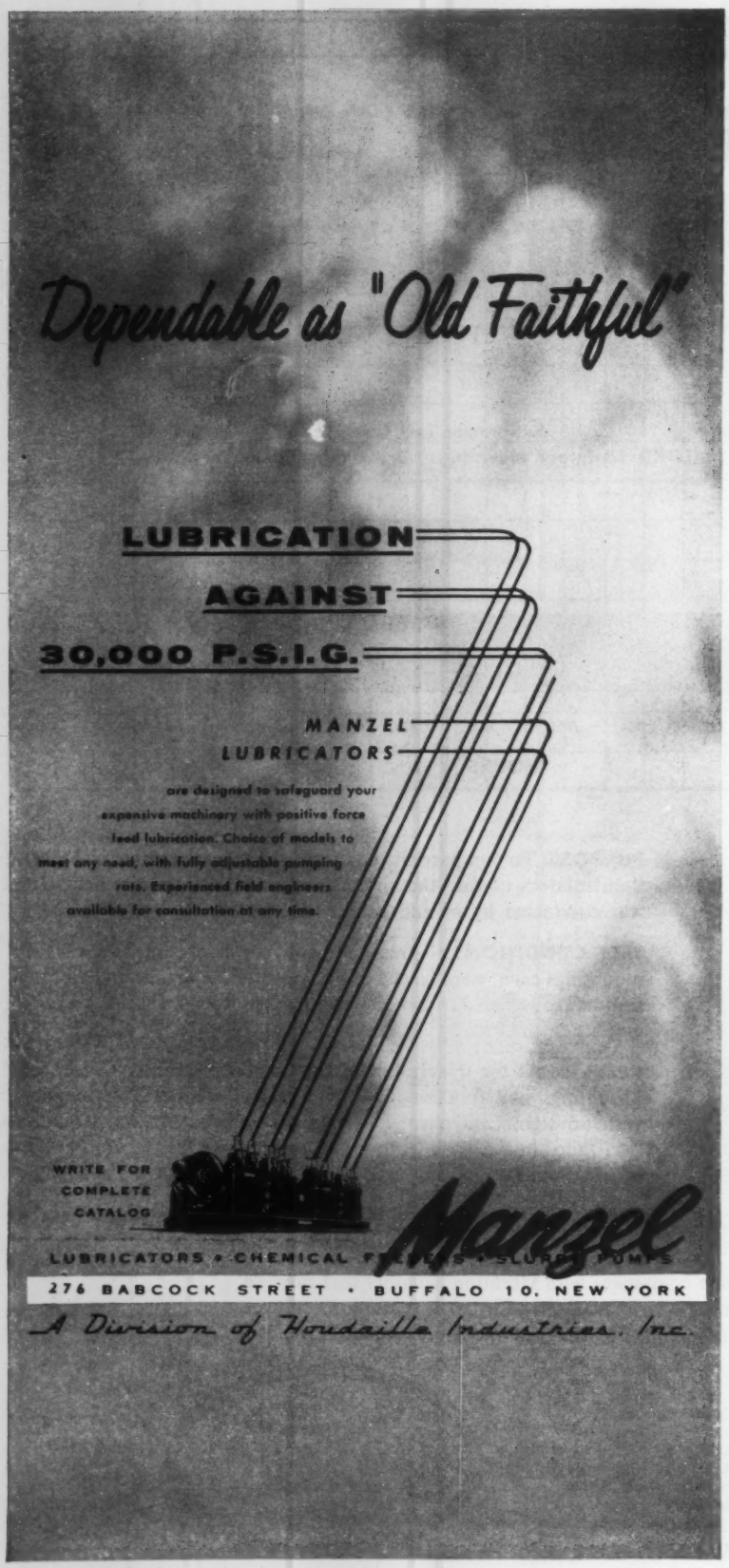
ATLANTA, GEORGIA - CEdar 7-1123
BOSTON, MASS. - HAncock 6-9135
CHICAGO, ILL. - Michigan 2-6010
CLEVELAND, OHIO - SHadyside 9-3175
DALLAS, TEXAS - Riverside 1-3392
DAYTON, OHIO - Michigan 8871
DETROIT, MICH. - TRinity 4-2060
KANSAS CITY, MO. - WEstport 1-0138
LOS ANGELES, CAL. - HOllywood 4-7593
NEW YORK, N. Y. - Circle 7-3326
PHILADELPHIA, PA. - PEnnypacker 5-3559
"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

designers and producers of bonded rubber products since 1924

Circle 550 on Page 19


Dependable as "Old Faithful"
LUBRICATION
AGAINST
30,000 P.S.I.G.
MANZEL
LUBRICATORS
are designed to safeguard your expensive machinery with positive force feed lubrication. Choice of models to meet any need, with fully adjustable pumping rate. Experienced field engineers available for consultation at any time.
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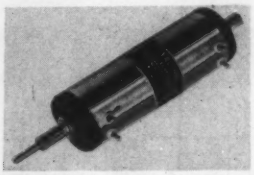
New Parts

shafts from a single input shaft. Functions of shafts can be reversed, resulting in a unit which can be utilized in a high-speed gear-changing device or rapid re-



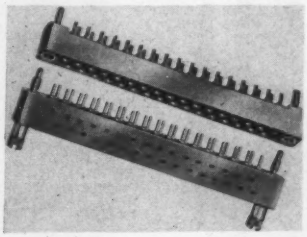
versing mechanism. Transmitted torque is 16 oz-in. minimum. **Sterling Precision Corp.**, 34-17 Lawrence St., Flushing 54, N. Y.

Circle 744 on Page 19

Printed-Circuit Connector

has polarizing screwlocks

Designed for printed-board or printed-cable applications, Series 683 right-angle printed-circuit connector has polarizing screwlocks. Connector meets airframe requirements for vibration and high altitude. Contact spacing is based on 0.100 grid in accordance with EIA specifications. Connector is available with 11 or 33 contacts. Standard molding compound is mineral-filled Melamine. In addition to regular solder cup for No. 20 AWG wire, receptacles can also be supplied with taper-pin ter-



mination for solderless wiring. **DeJur-Amsco Corp.**, Electronic Sales Div., 45-10 Northern Blvd., Long Island City 1, N. Y.

Circle 745 on Page 19

Vertical Gearmotors

have high load-carrying capacities

Type MV vertical gearmotors are equipped with mounting base for floor, ceiling or wall mounting, in either standard or hollow-shaft models. They are double-reduction

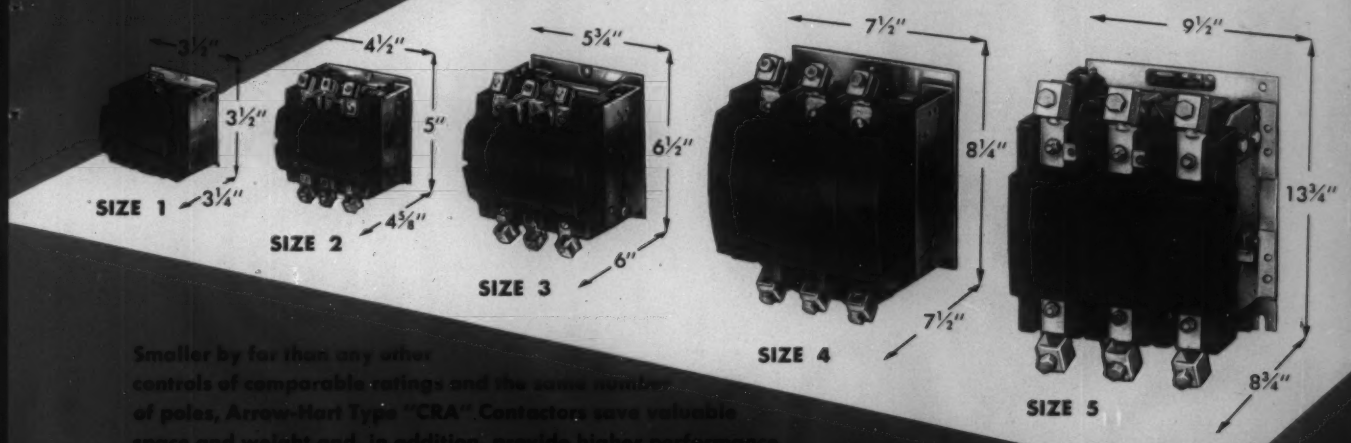
Circle 551 on Page 19

Circle 552 on Page 19→

ARROW AH HART

POWER CONTACTORS

give you FINER PERFORMANCE in HALF the size



Smaller by far than any other controls of comparable ratings and the same number of poles, Arrow-Hart Type "CRA" Contactors save valuable space and weight and, in addition, provide higher performance standards with greater dependability, longer life and faster, easier installation and maintenance. Available in a complete line — from Size 0 to Size 5 — they provide the right control for all your requirements.

CONSTRUCTION FEATURES - -

Straight-Thru Wiring is quickly, easily accessible from the *front*. Double break contacts, of silver cadmium oxide for weld resistance on high inrush currents, are accessible from the front for fast, simple inspection or replacement. Molded AC operating coils resist moisture and dirt . . . normally last the life of the relay itself. Resinox base and hood provide maximum arc and tracking resistance.

OPERATING FEATURES - -

Magnets are designed for high-efficiency, low wattage operation. Exclusive mechanical design — available only on Arrow-Hart Controls — has proved its ability to operate dependably under the most adverse conditions.

EXTRAS AVAILABLE - -

If required, Arrow-Hart Type "CRA" Contactors can be supplied with: NEMA Type I, IV, VII, IX & XII Enclosures. Sizes 0, 1 & 2 can be supplied with coils & magnets for up to 250 volts DC.

"CRA" SELECTOR GUIDE

"CRA" UNIT	POLES	AUXILIARY HOLDING SWITCH	CONTINUOUS RATINGS IN AMPERES	EXTRA AUXILIARY SWITCHES
Size 0	2-5, N.O.	Optional	18	Yes
Size 1	2-5, N.O.	Optional	27	Yes
Size 2	2-5, N.O.	Yes	45	Yes
Size 3	2-5, N.O.	Yes	90	Yes
Size 4	2-5, N.O.	Yes	135	Yes
Size 5	3-5, N.O.	Yes	270	Yes

RESISTIVE HEATING LOADS (KW)

"CRA" UNIT		A-C VOLTAGE			
SIZE	PHASE	115	230	440	550
1	1	2.5	5	10	12.5
	3	4	8	17	21
2	1	5	10	20	25
	3	8.5	17	34	43
3	1	10	20	40	50
	3	17	34	68	86
4	1	15	30	60	75
	3	26	52	105	130
5	1	30	60	120	150
	3	52	105	210	260

HORSEPOWER RATINGS

"CRA" UNIT		A-C VOLTAGE		
SIZE	PHASE	110	220	440/550
0	1	1	2	3
	3	2	3	5
1	1	2	3	5
	3	3	7½	10
2	1	3	7½	10
	3	7½	15	25
3	1	7½	15	25
	3	15	30	50
4	3	25	50	100
5	3		100	200

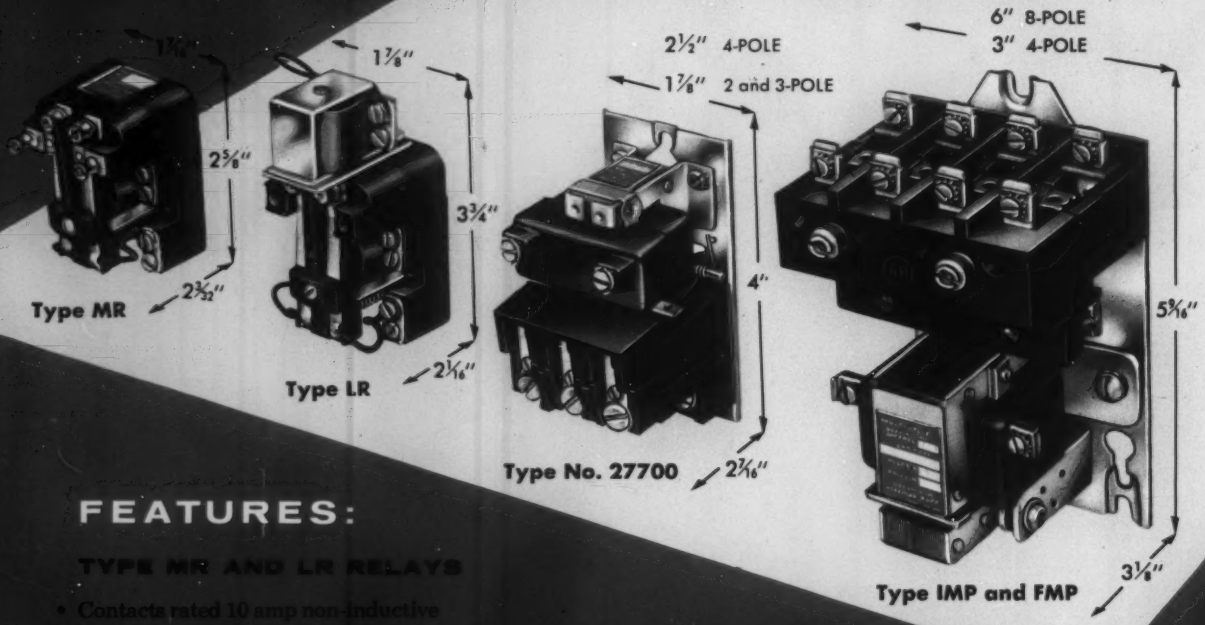
PLEASE TURN THE PAGE FOR ADDITIONAL INFORMATION . . .

ARROW AH HART

RELAYS

have EVERY feature you want --

LONG LIFE, ADVANCED DESIGN, VERSATILITY



FEATURES:

TYPE MR AND LR RELAYS

- Contacts rated 10 amp non-inductive
- Low coil consumption
- Contacts have wipe action
- A, B and C type contacts available
- Available 1 to 4 poles
- Coils available in all common A.C. or D.C. voltages
- Exceptionally long life
- Type LR -- Latch-in or Latch-out or both

HEAVY DUTY RELAY, Type 27700

- Ideal for the new, heavy duty commercial appliances
- 20 amps per pole at 300V A.C.
- 120 amps interrupting capacity
- Coil inrush 12 watts (Approx.)
- Coil sealed 2.5 watts (Approx.)
- Available 2, 3 or 4 poles A.C.

TYPE IMP AND FMP

- Size 00 and 0 for operation to 600V A.C. or 250V D.C.
- Available with 2, 3, 4, 6 or 8 poles
- Instant interchangeability of contacts -- no disassembly or reassembly of contacts
- Plug-in receptacle available for all sizes
- Latch attachment can be added by user
- Latch is convertible to latch-in or out or both
- Same coil and magnet regardless of number of poles

USE THIS COUPON TO SEND FOR COMPLETE INFORMATION ON ARROW-HART RELAYS AND POWER CONNECTORS

AH

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY

103 Hawthorn Street, Hartford 6, Connecticut • Motor Control Division

Please send me complete engineering data on:

☐ Type "MR" and "LR" Relays ☐ Type "IMP" and "FMP" Relays

☐ 20-Ampere Relays ☐ Type "CRA" Contactors

☐ I am also interested in other industrial motor controls.

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MD

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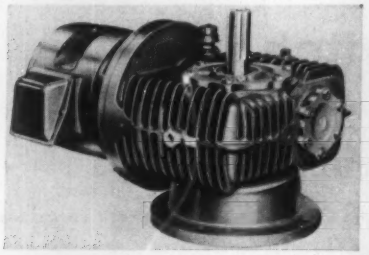
Quality since 1890

WIRING DEVICES • MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES

Branch Offices and Sales Engineers Throughout the United States

units with a helical primary and double-enveloping worm gear secondary. Hour-glass worm meshes with throated gear, providing high load-carrying capacities. One-eighth of gear teeth are always in mesh, spreading unit loads over greater area. Sizes available handle 1 to 15-hp standard NEMA



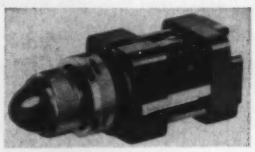
D-flange motors. Gearmotors are furnished in 27 standard output speeds from 7.3 to 525 rpm. **Cone-Drive Gears,** Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

Circle 746 on Page 19

Pilot Light

has push-to-test circuit for bulb checking

Bulb is checked in this pilot light by manually pushing on the color cap. In the test position there is a positive-contact "feel" to indicate that test circuit is connected. Oil-tightness of the unit is main-



tained in both the normal and the depressed or test position. **Square D Co.,** 4041 N. Richards St., Milwaukee 12, Wis.

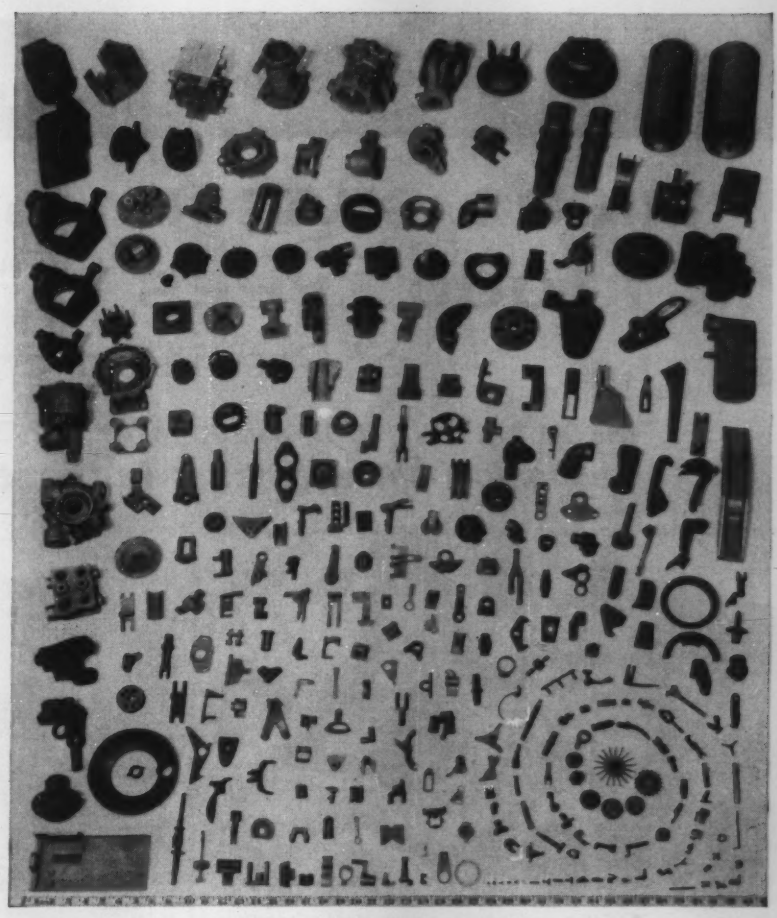
Circle 747 on Page 19

Detachable Hose Fitting

in ¼ to 1-in. pipe sizes

Type DT hose fitting has solid one-piece ferrule, and metal-to-metal seat. It consists of only three parts. Concentric grooves and ridges in internal flat seat of end connector make it unnecessary to

(*Please turn to Page* 250)



Investment castings

¼ ounce to 30 pounds . . . up to 12 inches in length . . . 160 ferrous and nonferrous alloys

Precision Metalsmiths makes them all—a million pieces for your production or a few at a time, as you develop a product. Pictured above are some of the investment castings we're making regularly.

Cast to close tolerances and accurate in details, such parts require surprisingly little finishing. Expensive pre-assembly machining is avoided, since complicated parts are produced as single units. We do the assembling with expendable patterns.

Send for the free book, "Pour Yourself an Assembly", describing this time-saving method. Precision Metalsmiths, Inc., 1083 East 200th Street, Cleveland 17, Ohio.

pour yourself an assembly with

PRECISION METALSMITHS, Inc.

Investment Castings

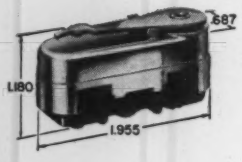
Circle 553 on Page 19

MICRO SWITCH Precision

...FIRST IN PRECISION SWITCHING

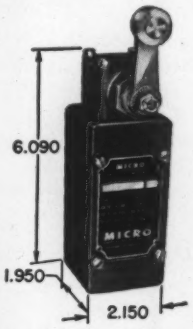
MICRO SWITCH offers over 10,000 TYPES of Precision Switches—

Many are fully described with electrical ratings and mechanical characteristics ***in these nine catalogs***



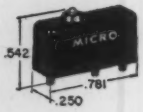
• Many types of MICRO SWITCH basic switches are specially designed to meet rigid aircraft requirements. Type HS Hermetically Sealed Switch is one of these. The precision snap-action unit is hermetically sealed within a metal chamber. Conductors to terminals are sealed in glass. Shown is a Type HS which has a lever-type actuator. Also available with leaf and roller actuators.

Catalog 78—Basic switches for airborne equipment



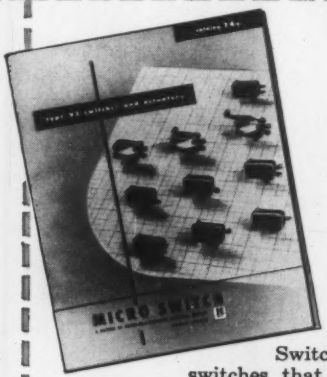
• MICRO SWITCH precision switches are used to perform vital functions in every type of industrial equipment. A most versatile heavy duty limit switch is the Type ML Series. This is available in sealed, two-circuit and explosion-proof models. Shown is the ML model with adjustable roller-arm actuator. Also available with plunger and roller-plunger actuators.

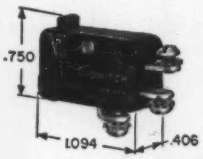
Catalog 101—Switches for Industry



• MICRO SWITCH subminiature switches combine the features of extremely small size and light weight with high electrical capacity, precise operation and long life. Shown is Type 1SM1, the basic subminiature switch. This switch is assembled into auxiliary actuator brackets, pushbutton assemblies and rotary actuators. It is ideal for applications where space limitations are critical.

Catalog 75—Subminiature Switches

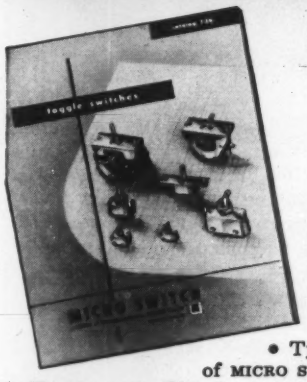


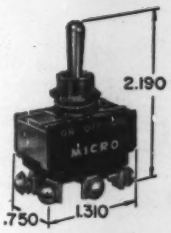


• MICRO SWITCH Type V3 Switches are ultra-small precision switches that have the highest electrical rating for their size of any switches available. The V3-1 model shown meets the exacting requirements of designers for an extremely small switch without sacrifice of quality. These switches are available in a wide variety of terminal designs, contact arrangements and operating characteristics.

Catalog 74—Type V3 switches and actuators

Switches have uses unlimited



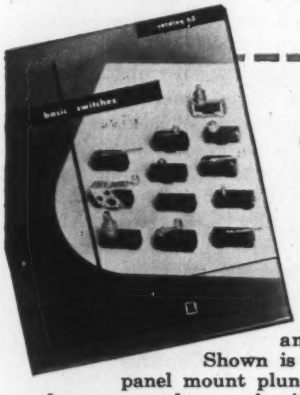


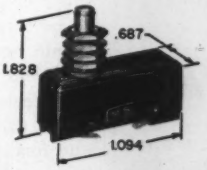
• Typical of the broad line of MICRO SWITCH Toggle Switches is Type 12TS1. Five features give it superior service and life characteristics: (1) greater over-surface creepage (2) sealed toggle lever (3) no return springs in momentary versions (4) solid silver contacts and (5) copper moving contact carrier.

Catalog 73—Toggle Switches

• Many of the MICRO SWITCH precision switches shown in this catalog are also widely used in commercial applications other than aircraft. One such switch is the versatile Type EN. This switch is completely sealed and easily mounted in cramped space. The 1EN1-6 model shown contains two SPDT precision switching units giving a DPDT contact arrangement. Also available with linkage type actuators.

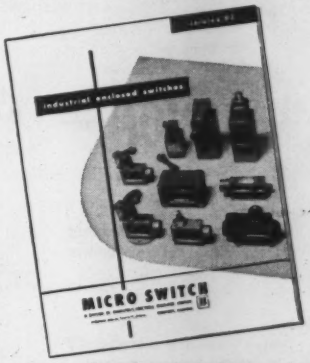
Catalog 77—Enclosed switches for airborne equipment

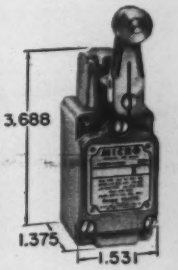




• This catalog covers a wide variety of MICRO SWITCH basic switches, auxiliary actuators and terminal enclosures. Shown is the Type BZ-2RQ1 with panel mount plunger. This switch can be used as a manual or mechanical pushbutton or for in-line operation where considerable over-travel is desired. Panel mounting permits adjustment of operating point with respect to the actuating device.

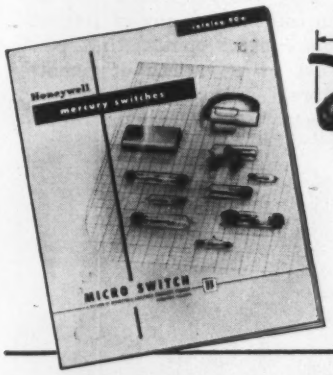
Catalog 62—Basic Switches for Industrial and commercial applications





• An enclosed switch is a switch enclosed in a durable metal housing to protect the switching element from physical damage. An excellent example is the small, versatile 2-circuit enclosed limit switch of the Type 1LS1. It is completely sealed and has high electrical capacity. Adjustability features suit it to all types of industrial applications where space limitation is a prime factor in switch selection.

Catalog 83—Industrial enclosed switches



• The mercury switches shown in this catalog are standard designs for use in a-c or d-c applications. They provide reliable, trouble-free service in clean atmosphere as well as in locations affected by dust, fumes, spray or splash. Shown is the ultra-small Type AS408 which has been widely used by manufacturers of animated displays, home freezer units, alarms and other control and indicating devices.

Catalog 90—Honeywell Mercury Switches

There is—or can be—a MICRO SWITCH Precision Switch to meet every switch requirement. Why not consult MICRO SWITCH Engineering Service today on YOUR switch problem. It's as close as your nearby branch office.

MICRO SWITCH

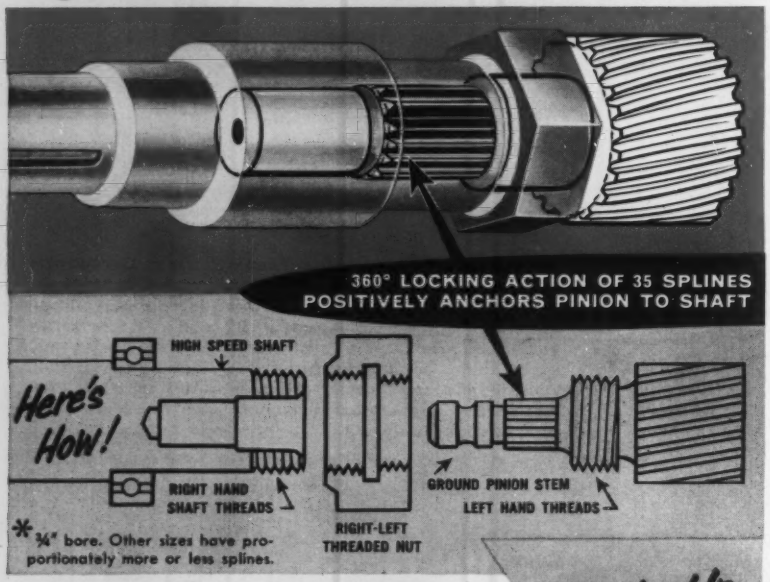
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

FOOTE BROS. SPLINE DRIVE PINION

Takes 35 "Bites" *

to guarantee better power transmission


360° LOCKING ACTION OF 35 SPLINES
POSITIVELY ANCHORS PINION TO SHAFT
HIGH SPEED SHAFT
Here's How!
RIGHT HAND SHAFT THREADS
RIGHT-LEFT THREADED NUT
GROUND PINION STEM LEFT HAND THREADS

* ¼" bore. Other sizes have proportionately more or less splines.

SPLINE DRIVE PINION — advantages:

1. MORE LOCKING AREA

Self-broaching splines provide more internal locking surface than any other pinion . . . assure positive anchoring, even under reversing conditions.

2. GREATER STRENGTH

Gear and shank are machined from one piece. Solid construction and spline lock provide greater strength—no weakness due to projecting keyway.

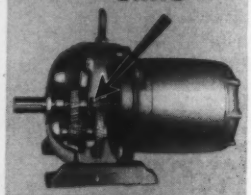
3. PERMANENT, ACCURATE ALIGNMENT

Self-centering action of ground pinion shank in the accurately bored high speed shaft assures accurate assembly and alignment for smoother performance.

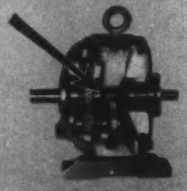
4. DUTI-RATED GEARING

Foote Bros. Spline Drive Pinions have the famous Duti-Rated Gear—harder, tougher and more accurate, with greater load carrying capacity for their size than any other gearing.

Standard In GEARMOTORS AND LINE-O-POWER UNITS



GEARMOTOR



LINE-O-POWER UNIT

SPLINE DRIVE PINIONS are another example of Foote Bros. leadership . . . another reason you can be sure you're buying the finest when you buy Foote Bros. Power Transmission Equipment.

this trademark stands for the finest industrial gearing made

FOOTE BROS. Duti-Rated LIFETIME GEARING

T. M. REG. U. S. PAT. OFF.

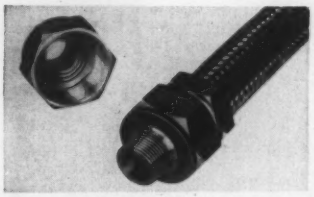
FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4567 South Western Boulevard Chicago 9, Illinois

New Parts

(*Continued from Page 247*)



smooth, file, or grind flat end of flexible tubing, which merely has to be deburred. Grooves and ridges obtain a leakproof connection effectively. Male fittings are available in standard pipe sizes from ¼ to 1 in. NPT. **Seamlex Co. Inc.**, 41-23 Twenty-Fourth St., Long Island City, N. Y.

Circle 748 on Page 19

Magnet Wire

is polyester film-coated

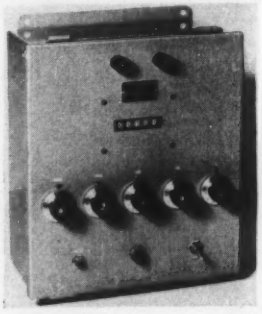
Anatherm polyester film-coated magnet wire has a high level of thermal stability, permitting use in motors, transformers, and electronic equipment. Wire gives high chemical stability, excellent abrasion resistance, and high dielectric strength. It is available in single and heavy film thicknesses in AWG sizes 15 through 25. **Anaconda Wire & Cable Co.**, Muskegon, Mich.

Circle 749 on Page 19

Predetermining Counter

has 100,000 possible control points

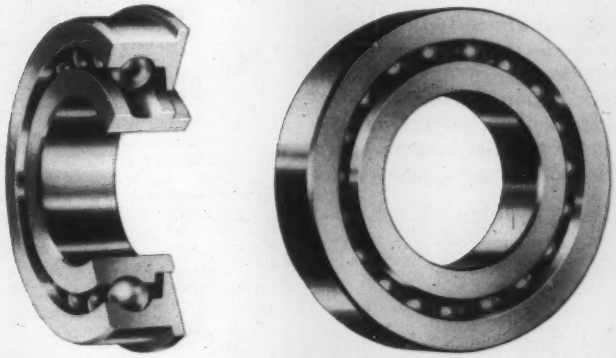
Automatic predetermining control unit solves machine, process control, and materials-handling problems. Five control knobs provide ease in establishing any of 100,000 possible control points. Unit permits use of a variety of remote actuators, switches, contactors, and electric eyes. Maximum count-

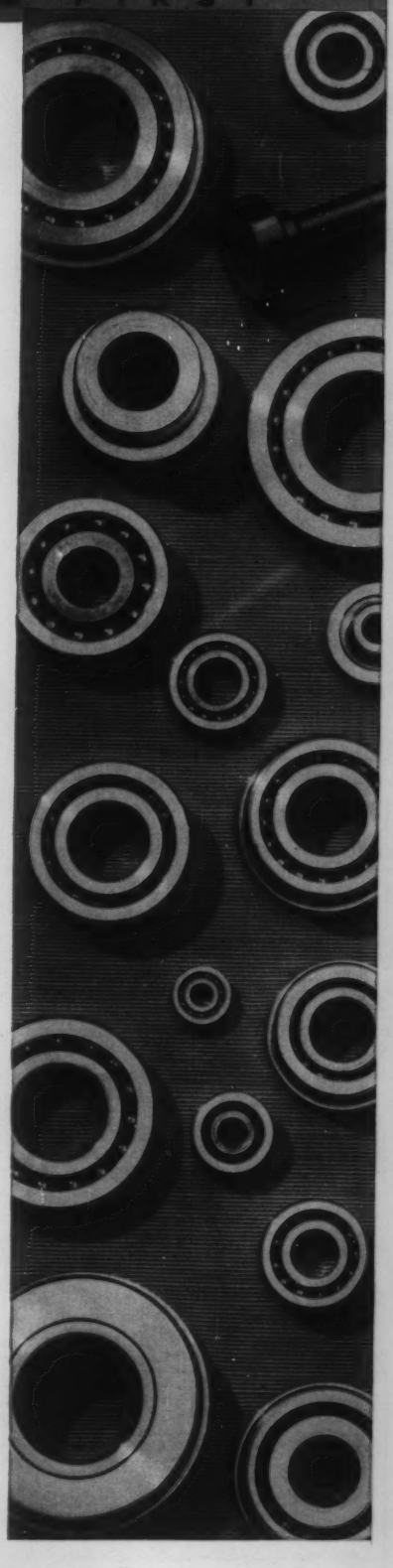


ANOTHER HEIM *Unibal* FIRST

HEIM INTRODUCES THE NEWEST IDEA IN BALL BEARINGS

without insertion grooves or inserts





A most unusual, NEW concept in ball bearing design . . .

Here is a commercial ball bearing with solid, unbroken machined inner and outer raceways, yet with a full complement of balls.

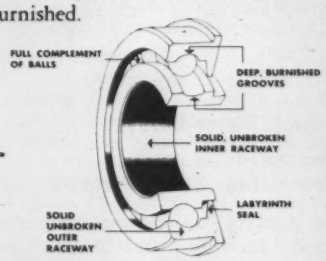
It has deep, burnished ball grooves that are deep carburized and hardened. The revolutionary and radically new method of manufacture permits assembly of these ball bearings in a way that borders on the mysterious and challenges the imagination.

Radial and axial load capacities are increased because of the raceway construction, resulting in longer bearing life.

Unibal Ball Bearings can be furnished in single row, double row and flanged types; to close tolerances on bore and outside diameter; and with controlled radial and axial play.

Close, integral labyrinth seals on one or both sides are another unusual feature, where sealed type bearings are required. Extremely narrow widths and small diameters can be furnished.

NOTE THIS CONSTRUCTION . . .



Special circular with load ratings and dimensions on the new Unibal Ball Bearings is available.

HEIM also makes the Unibal Spherical Bearing Rod End. Send for complete catalog of all Heim bearings. Write direct or see your local bearing distributor.

THE HEIM COMPANY / Fairfield, Connecticut

How Alcoa Aluminum Fasteners make good windows even better

MEETS AWMA STANDARDS!

You can meet the highest standards of quality and the specifications of the AWMA (Aluminum Window Manufacturers Association) for prime windows of aluminum when you assemble with Alcoa® Aluminum Fasteners. Perfect color match and protection against both galvanic and atmospheric corrosion make for lasting good looks . . . consumer satisfaction. Complete stocks carried by your local Alcoa distributor fill every requirement. He is listed in the Yellow Pages of your telephone directory.

ALCOA ALUMINUM FASTENERS

Your Guide to the Best in Aluminum Value

NEW! "ALCOA THEATRE" Exciting Adventure Alternate Monday Evenings

Fill out coupon for facts, samples

Aluminum Company of America
2244-L Alcoa Bldg., Pittsburgh 19, Pa.
Gen. emen: Please send complete specification data and samples of Alcoa Aluminum Fasteners.

Name_____

Title_____

Company_____

Address_____

Circle 557 on Page 19

New Parts

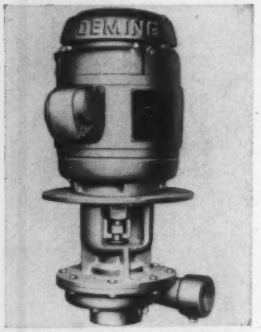
ing speed is 600 per min. Reset time of 2 sec allows completely automatic recycling, automatic reset in preparation for following cycle, or pushbutton reset. **Veeder-Root Inc.**, Electronic Control Div., Hartford 2, Conn.

Circle 750 on Page 19

Circulating Pump

circulates up to 500 gpm against heads to 100 ft

Vertical immersion-type circulating pump is designed for use in air conditioning, cooling and heating circulation systems, brine pumping, and for circulation systems in commercial laundry equipment, industrial parts washers, and



other process equipment. It is leakproof and requires no liquid seal or stuffing box. Pump circulates up to 500 gpm against heads to 100 ft. It is available in 1, 1½, 2, and 3-in. sizes for 1750 or 3500 rpm. Construction features include graphite-impregnated steady bearing, stainless-steel pump shaft, and optional bronze impeller. **Deming Co.**, 800 Broadway, Salem, Ohio.

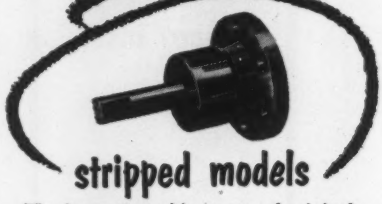
Circle 751 on Page 19

Contact Meter-Relays

for use in Wheatstone bridge circuits

New contact meter-relays are designed for use in Wheatstone bridge circuits. Unit gives control action on signal changes of 1/10 of 1 per cent or less in the active leg of a bridge. Speed is less than a half-second. Meters match bridge circuits in current and voltage sensitivity, and in damping resistance. They are usually furnished with a

VIKING PUMPS any way you want them



stripped models

The internal working parts of original "Gear-within-a-gear" Viking pumps are available to fit into your integral casing. Conserves space, piping arrangement, drive equipment, etc. Available in 2/3, 1½, 3½, 5, 10, 18 GPM and larger. Positive, self-priming, capable of handling all types of liquids up to several hundred pounds discharge pressure, in many models.

custom models

No matter how you wish to apply the positive self-priming Viking pump, it can be custom built in the size and casing design to fit your piping and drive arrangement. Thousands of individual problems have been successfully answered with specially designed Viking "Gear-within-a-gear" pumps.

standard models

Pick any standard Viking pump in 21 sizes from 2/3 to 1050 GPM, in many types of mounting and drive arrangements. They are available from over 750 cataloged models.

Send your pumping problem today and ask for bulletin 57Sh.

VIKING PUMP CO.
Cedar Falls, Iowa, U.S.A.

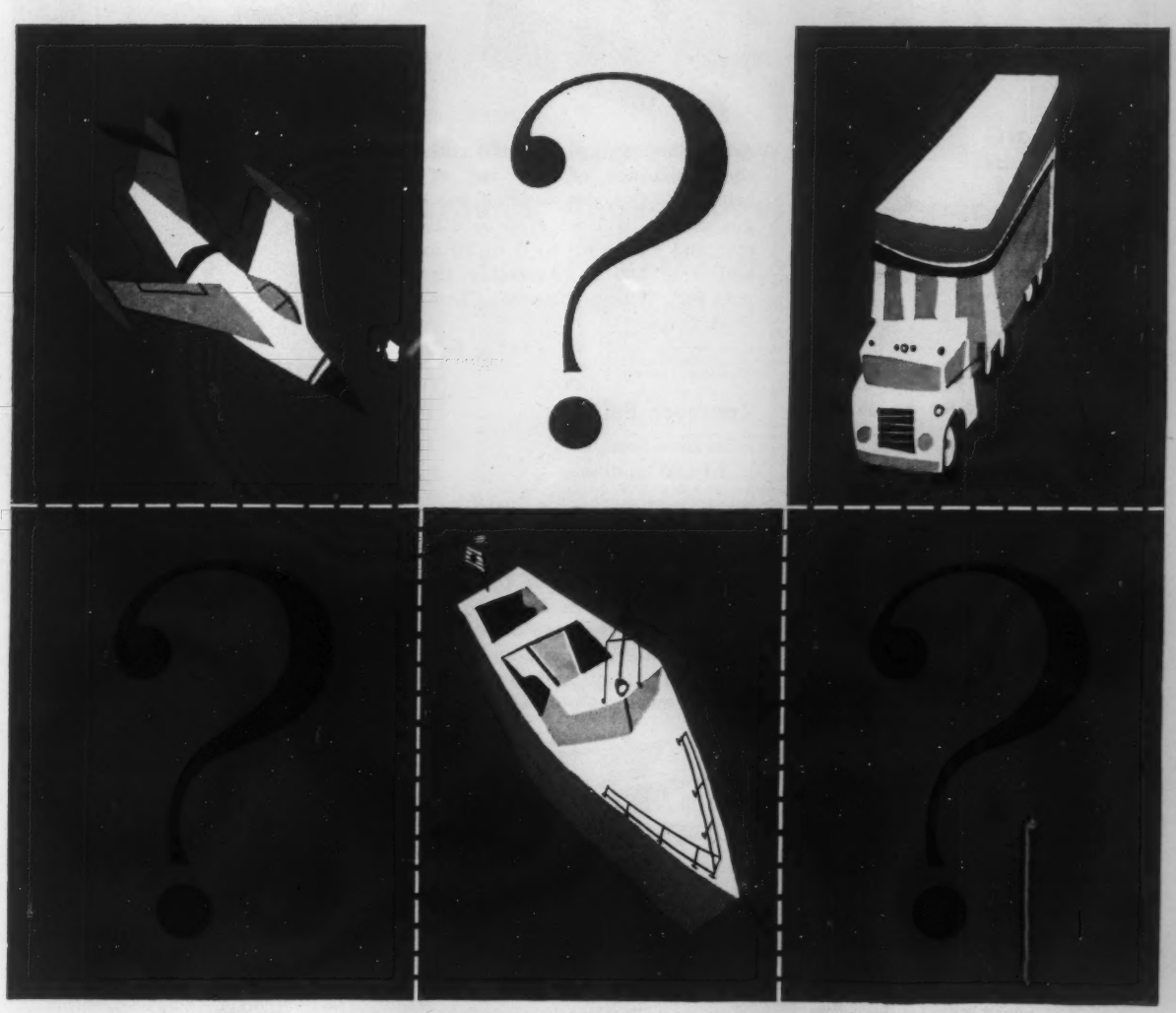
In Canada, it's "*ROTO-KING*" pumps

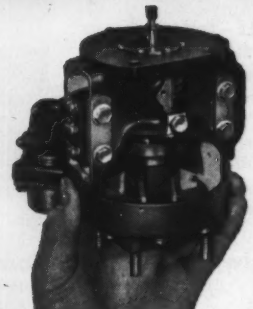
See our catalog in Sweet's Product Design File

Circle 558 on Page 19

Can you use . . .

switches triggered by speed





AC engineers have developed speed sensing switches so accurate that they operate . . . and continue to operate . . . within limits of .5% . . . This is the most sensitive speed switch yet produced . . . and the most accurate method of synchronizing up to four critical turbine engine functions with pre-selected RPM. Current applications bear out this accuracy and sensitivity over switching ranges from 500 to 4600 RPM. Newly developed models are effecting a dramatic increase in range. The AC Speed Sensing Control is lightweight, weighing less than four pounds. It withstands high engine vibration. It will hold calibration and operate without attention for periods longer than those recommended for jet engine overhauls. For more information about automatic control of speed-related electrical switching operations, give AC's Milwaukee group a call. *If you are an electrical or mechanical engineer and feel you might like to work with AC in Milwaukee, write Mr. Cecil Sundeen, Supervisor of Technical Employment, in care of . . .*

AC . . . THE ELECTRONICS DIVISION OF GENERAL MOTORS, MILWAUKEE 1, WISCONSIN

Afterburner Fuel Controls • Bombing Navigational Computers • Emergency Fuel Controls • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes Inertial Guidance Systems • Manifold Air Pressure Regulators • Speed Sensitive Switches • Speed Sensors • Three-Way Selector Valves • Torquemeters

GEAR-GRIP

The most revolutionary Flexible Coupling Design Development in a century!

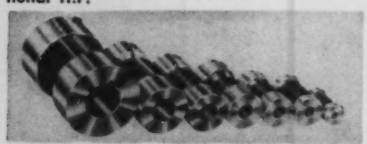
Now available for sub-fractional, fractional and integral H. P.

Ability of rubber Flex-Element to float between captive end fittings distributing load similar to universal joint action.

- Load Ranges—1/12 H.P. through 30 H.P.
- Shaft Sizes—1/8 through 1-7/8.
- Specified exact length to design requirements per series.
- Prevention of end thrust among many other design advancements.

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.

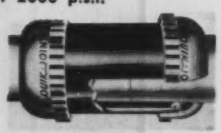


4R 3R 2R 1R 0R 00R

- True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.
- Lengths varied to design specifications in each series.
- Load ranges—1/15 to 1½ H.P.
- Shaft sizes—3/16" to ¾".

Quik-Joint Steel Compression Pipe Fittings

- UL approved for hazardous fluids.
- Guaranteed for 2000 p.s.i.
- Allows 7° angular deflection.
- No threading of pipe required.
- Special Silicone Gasket for Steam applications.

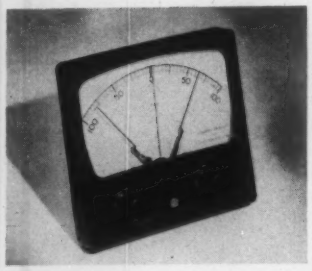


Write for Catalogs and Technical Bulletins.

Guardian
PRODUCTS CORP.
COUPLING DIVISION
Dept. M-117
Michigan City, Indiana

Circle 559 on Page 19

New Parts



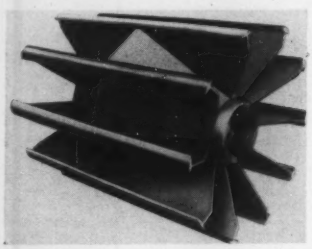
resistance having a 1:10 ratio to the resistance of any leg of a bridge. Full-scale sensitivities begin with 0 to 5 mu amp or 0 to 5 mv, and range up to 0 to 50 amp and 0 to 500 v. **Assembly Products Inc.**, Wilson Mills Rd., Chesterland, Ohio.

Circle 752 on Page 19

Conveyor Pulleys

in sizes from 8 to 60 in. diam

Steel self-cleaning conveyor pulleys are available in 3000 standard sizes from 8 to 60 in. in diam, from 8 to 66 in. in face width, and in bore sizes from ½ to 10 in. Self-cleaning cone design eliminates material build-up between belt and pulley, and prevents belt misalignment. Outer edge of each



individual wing is protected by a half-oval bar that reduces belt strain and provides maximum traction. **Van Gorp Mfg. Co. Inc.**, Box 123, Pella, Iowa.

Circle 753 on Page 19

Metal-Film Resistors

are full-rated at 150 C

Series 77 metal-film resistors can be used at full ¼-w rating in temperature of 150 C. They employ no wire for resistance element, and can be used in high-frequency and pulse circuits where wire-wound units are unsuitable. Resistance

. . . bend to the shape you need

Here is your quick, efficient and economical answer to hundreds of electrical heating problems. Clamp to metal surfaces, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts.

Versatile Chromalox Electric Tubular Heaters may be ordered in straight lengths or factory formed to nearly any shape required.

Select sheath metal and wattage to match your application and operating temperatures.

FREE — Send today for these 2 BIG HEATING HELPS

Catalog 50 — describes complete Chromalox line of "packaged" heaters, elements and controls.

Booklet F1550 — "101 Ways to apply Electric Heat."

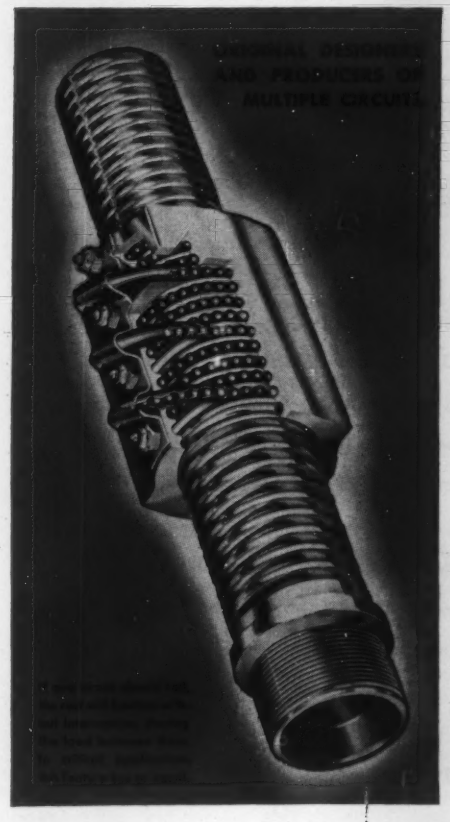
C-2110-A

Edwin L. Wiegand Company
7575 Thomas Boulevard, Pittsburgh 8, Pa.

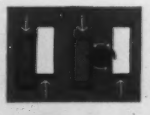
Circle 560 on Page 19

SAGINAW b/b SCREWS are guaranteed 90% EFFICIENT!

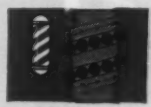
Require 4/5 LESS torque than Acme Screws for same linear output on Actuator and Positioner Applications! Saves space, weight!



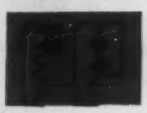
WHAT IT IS AND HOW IT WORKS



Let's start at the beginning, with the familiar principle that there's far less friction in *rolling* than in *sliding*. By applying this principle,



Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



the *Saginaw ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.

At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

SIX DESIGN ADVANTAGES

1. Vital Power Savings. Permit much smaller motors with far less drain on electrical system, simpler circuitry.

2. Space/Weight Savings. Screws themselves are smaller, lighter; permit smaller motors and gear boxes; eliminate auxiliary equipment required by hydraulics.

3. Precise Positioning. Machine-ground type will position components far more precisely than hydraulics or pneumatics; tolerances on position are held within .0006 in./ft. of travel.

4. Temperature Tolerance. Normal operating range from —75° to +275° F.; in selected materials, will function efficiently as high as +900° F.

5. Lubrication Latitude. If lube fails, will still function with remarkable efficiency. Units have been built and qualified for operation without lubrication.

6. Fail-Safe Performance. Far less vulnerable than hydraulics; Gothic-arch grooves, yoke deflectors and multiple circuits provide added assurance against failure.

SAGINAW b/b SPLINE

Utilizing the same basic *gliding ball* principle, Saginaw has developed the *Saginaw b/b Spline* which radically increases the efficiency of transmitting or restraining high torque loads.

Averages 40 times lower friction coefficient than sliding splines!

It can be fitted with integral gears, clutch dogs, bearing and sprocket seats, etc., for use with a wide variety of electrical units. Units have been built from 3 inches to 10 feet long—⅜ to 6 inches in diameter.

Available in custom machine-ground and stock rolled-thread types. Units have been built from 1½ inches to 39½ feet long—⅜ to 10 inches in diameter.

Saginaw ball bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND COUPON FOR NEW 1957 ENGINEERING DATA BOOK

or see our section in Sweet's Product Design File

Saginaw Steering Gear Division, General Motors Corp.
b/b Screw and Spline Operation
Dept. 6H, Saginaw, Michigan

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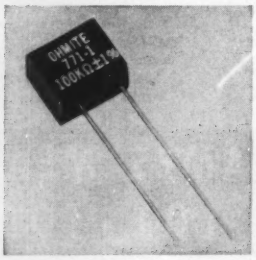
range available is 100 ohms to 300 K ohms. Standard tolerance is ±1 per cent. Hermetically sealed in a rectangular plastic case, units



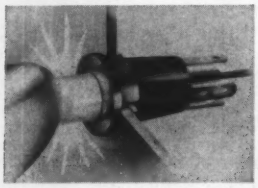
have axial or radial-type leads. They meet requirements of applicable military specifications. **Ohmite Mfg. Co.**, 3657 Howard St., Skokie, Ill.

Circle 754 on Page 19

Indicator Switch

has maximum diam of ⅝ in.

Pan-i-Lite switch is used for a variety of low-voltage indicating and switching applications. Push-button bulb-lens assembly is an integral unit designed for quick replacement from front of panel. Switch is available in operating voltages of 6, 12, and 28 v, in five colors. Having a maximum diam of ⅝ in., switch gives indication that can be seen at 180 deg and for unusual distances. Unit can be



wired as a momentary-contact pushbutton indicating switch or as a press-to-test indicating light. Switch is mounted in a 0.75-in. hole, in panels from 1/16 to 3/16 in. thick. **Alden Products Co.**, Dept. TS-62, Brockton, Mass.

Circle 755 on Page 19

Clutch Transmission

has input-torque rating of 700 lb-in.

Model 8100-EC automatic clutch transmission is adaptable to automation and other machinery. Unit

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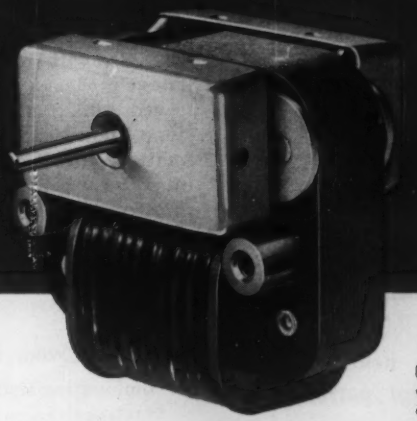
Unidirectional Small Motors

for your most critical applications where you need a good motor at an economical price



Model DYAB
with extra-large capacity oil cups

Leading manufacturers of top-quality products have found through years of experience that they can depend on Barber-Colman unidirectional motors to give long service with little attention. For example, several hundred thousand of the model shown above are in use in domestic refrigerators. After years of continuous operation *without relubrication* they are still performing perfectly. Other similar motors power office and vending machines, desk and heater fans, hair dryers, slide projectors, cooling fans, and blowers for electrical equipment. Many Barber-Colman motors are still in operation after 20 years of service. For dependable operation of your products, specify a Barber-Colman motor.

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Exceptionally high starting torque for quick, positive starting under adverse conditions

Generous oil reservoirs

Polished and ground stainless steel shafts which contribute to long bearing life under adverse conditions

Various models — .00065 to .02 hp (full load)

NEW CATALOG
of unidirectional motors

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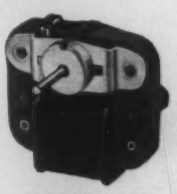
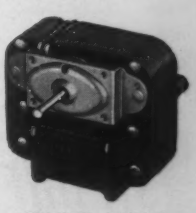


MODEL YAA



MODEL KYAF

BARBER-COLMAN COMPANY
Dept. W, 1273 Rock Street, Rockford, Illinois

Circle 563 on Page 19

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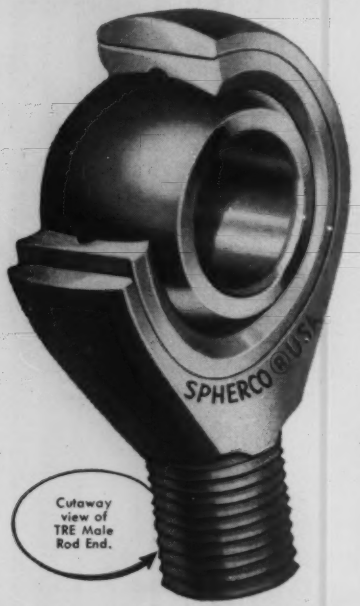

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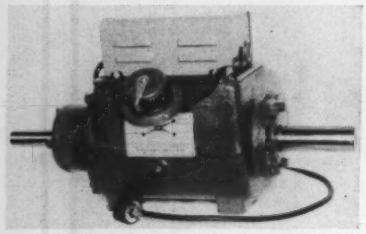
Circle 564 on Page 19

New Parts

permits speed change under power, and can be reversed without stopping or reversing motor. Input torque rating is 700 lb-in., and output rating is 2800 lb-in. Capacity of transmission is from 1:1 to maximum reduction of 6:1. By use of an adapter, a reverse is



possible, with limits to 3:1. Electric clutches are used to change speeds in connection with tape, time limit, cam, or other automatic controls. Hand control can also be used. Unit is built for horizontal mounting only. **Western Mfg. Co.**, 3400 Scotten Ave., Detroit 10, Mich.

Circle 756 on Page 19

Solenoid Brake and Drive

combination unit is for fractional-horsepower motors

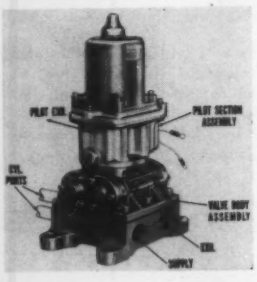
Combination solenoid brake and drive fits on standard drive shaft of most fractional horsepower motors. Solenoid is available in any desired voltage and cycle. Drive can be pulley, sprocket, sheave, or coupling. **Robot Appliances Inc.**, 7041 Orchard, Dearborn, Mich.

Circle 757 on Page 19

Hydraulic Valve

has locking manual actuator

Goldmodel Skyline valve, with O-ring sealed locking manual actuator, is designed to spring re-



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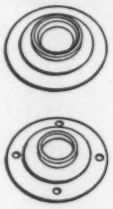

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Circle 565 on Page 19

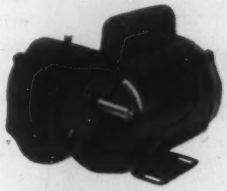
Now... Century announces a completely new line of fractional-HP right angle shaft type GEARMOTORS

New, "Smaller and Better" 48 and 56 Frame Century Motors

Weight reductions up to 1/3
Gearmotors operate in any position
Compact design saves space
Tapered roller bearings on low speed shaft
Finest rotary face-type oil seal on high speed shaft
Wide variety of mounting and motor types

Single reduction AGMA output speeds from 25 to 280 RPM (Double reduction as low as 4 RPM)

For floor mounting, complete with new type 56-Frame totally-enclosed, fan-cooled motor. External fan fully protected by cover. Substantial mounting on gear housing supports overhung loads on shaft. Type SC three phase motor shown. Ratings up to ¾ HP.



New IR 40 with 48-Frame motor. Gear housing shown is in one of eight possible positions. Open type single phase capacitor-start Type CS motor. Strong welded foot assembly and heavy motor frame assure smooth operation with severe sprocket loading. Ratings up to ½ HP.

Typical special purpose mounting to suit driven machine. Output shaft is vertical downward extension, properly sealed against oil leakage. Capacitor-start type motor has special smooth cover over capacitor and terminal connections to facilitate cleaning to meet sanitary requirements. Ratings up to ¾ HP.

Basic horizontal unit as assembled with 56-Frame open type motor. Motor is Type SC polyphase. Multi-speed, crane and hoist duty and other special types available. Note convenient vent and filling plugs on gear housing. Ratings up to ¾ HP.

Call your nearby Century District Sales Office or Authorized Distributor

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1/20 to 400 HP

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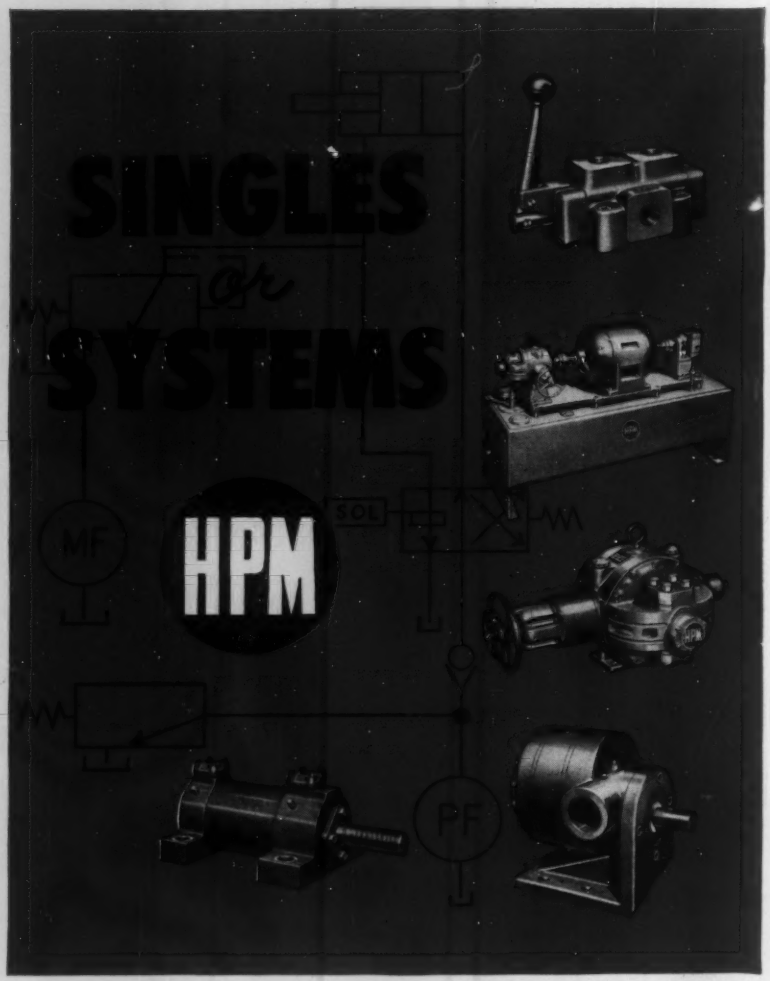

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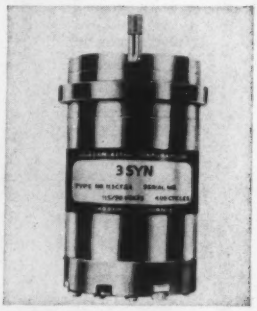
New Parts

turn to normal operation or to be locked easily in actuated position. A 90-deg turn of actuator locks oil-immersed solenoid in energized position. Valve has tested life of more than 40 million cycles. **Ross Operating Valve Co.**, Sales Dept., 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 758 on Page 19

Synchros

combine three functions in one unit



New 3Syn synchros combine in one unit the functions of a torque receiver, a control transmitter, and a torque transmitter. They operate from — 55 to 140 C in frame size 23. Synchros are interchangeable with MIL torque transmitters, control transmitters, and torque receivers. Standard units operate at 400 cycles, and are available on order to 10,000 cps. **Norden-Ketay Corp.**, Commerce Rd., Stamford, Conn.

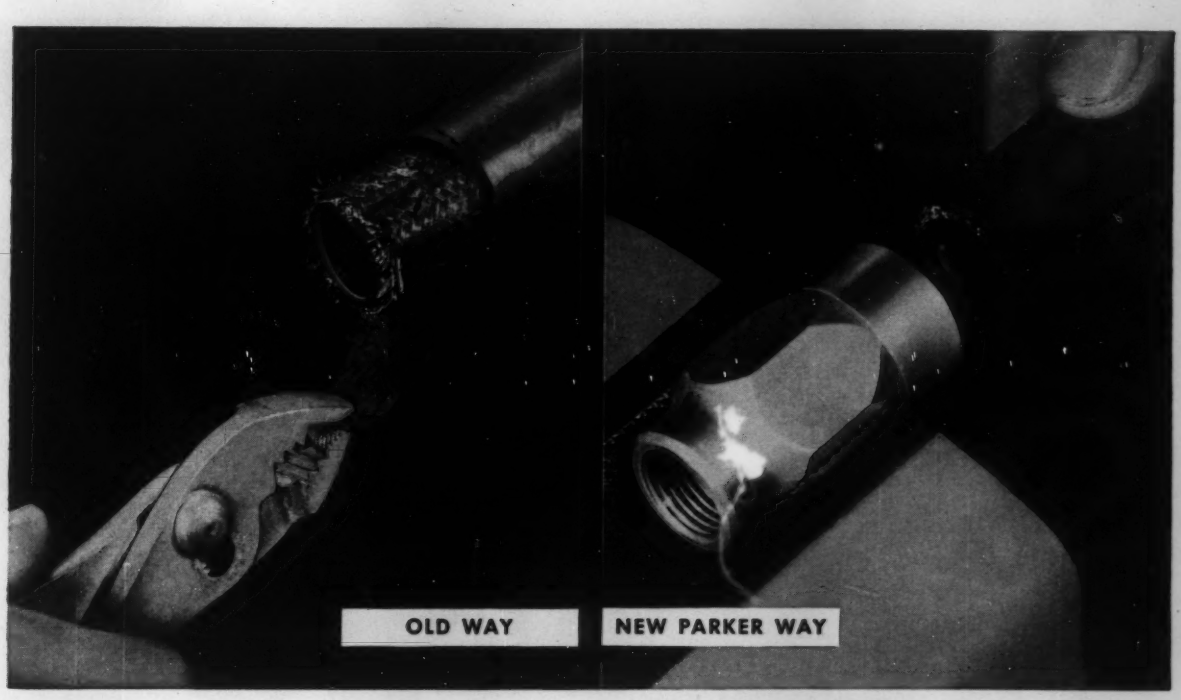
Circle 759 on Page 19

Potentiometers

for linear and nonlinear applications

Resistance values from ½ to 500,000 ohms with standard linearity of 0.5 per cent are available in Model WPI-5/8 precision potentiometers. Linear or nonlinear units are contained in an anodized aluminum case 1⅝ in. in diameter and 1-1/32 in. deep behind panel. Turret-type terminals mounted on fungusproof insulating strip of high-impact glass laminate are provided for circuit connection. **Waters Mfg. Inc.**, Boston Post Rd., Wayland, Mass.

Circle 760 on Page 19



New Parker No-Skive Hoze-lok

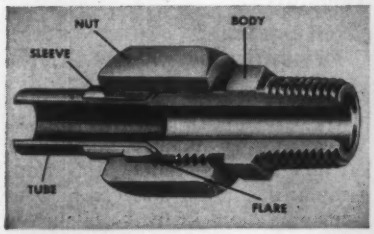
FASTER . . . EASIER . . . RE-USABLE

No more frustrating jobs of stripping off the covers of hydraulic wire-braid, rubber-covered hose! No more ragged hose ends that refuse to enter fitting sockets!

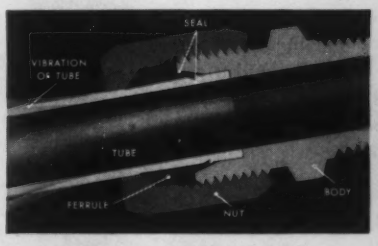
New Parker Hoze-lok Fittings save you all this time and trouble. Skiving of hose covers is *not* necessary. Simply screw the hose (with cover intact) into the socket and then screw the nipple in to complete the make-up. What could be easier . . . or more effective?

Versatile Hoze-lok Fittings are re-usable . . . an important benefit to users of your equipment. Select your fittings from the new series of Hoze-lok styles and sizes, with four different connecting ends and full range of adapters.

Ask your Parker Distributor or mail this coupon today for catalog about Parker Hoze-lok Fittings and for details about Parker Triple-lok and Ferulok.



Triple-lok Flare Fittings . . . the easiest, fastest, safest way to tube up even in close quarters. Leakproof even under severe vibration, high pressures. Meet S.A.E. Hydraulic Tube Fittings Standard.



Ferulok Flareless Fittings for high-pressure, heavy-wall tubing. Double seal makes Ferulok leakproof, vibration-proof. You can see the "bite." Meet S.A.E. Hydraulic Flareless Tube Fittings Standard.

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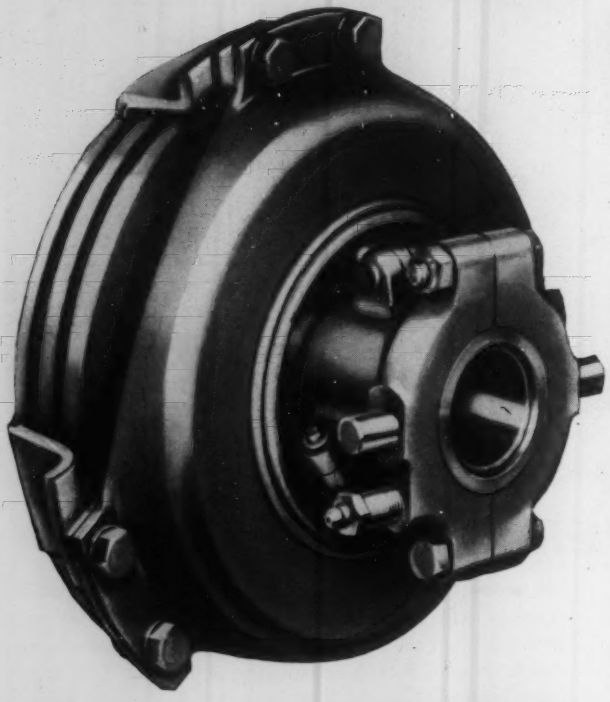


Small Spring Loaded

Automotive Spring Loaded

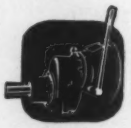
Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs


Speed Reducers

Control POWER Better

The Over-Center, Spring-Loaded clutch shown above—when used in farm tractor LIVE POWER TAKE-OFFS—enables the harvesting unit to be controlled independently of tractor propulsion. It is used in various other ways and in other industries. And it is but one of many types and sizes of ROCKFORD friction CLUTCHES that have been designed and built to meet specific needs. If you have a special power control or power transmission problem, ROCKFORD clutch engineers will be glad to help you solve it.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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CLUTCHES

ENGINEERING DEPARTMENT

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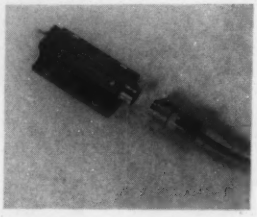
Cathode-Follower Probes

for aircraft and missile applications

Two Glennite cathode - follower probes, models F-460 and F-460HT, couple high - impedance piezoelectric accelerometers into telemetering recording equipment



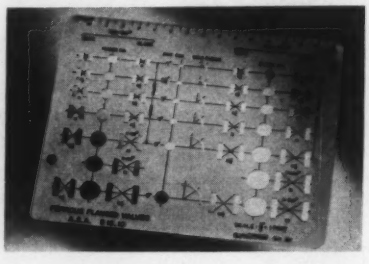
in airborne applications. They are individually mounted in a rubber compound to insure high performance under severe environmental conditions. Units operate at temperatures from −65 to 160 F for the F-460, and −65 to 350 F for the F-460HT. **Gulton Industries Inc.**, 212 Durham Ave., Metuchen, N. J.

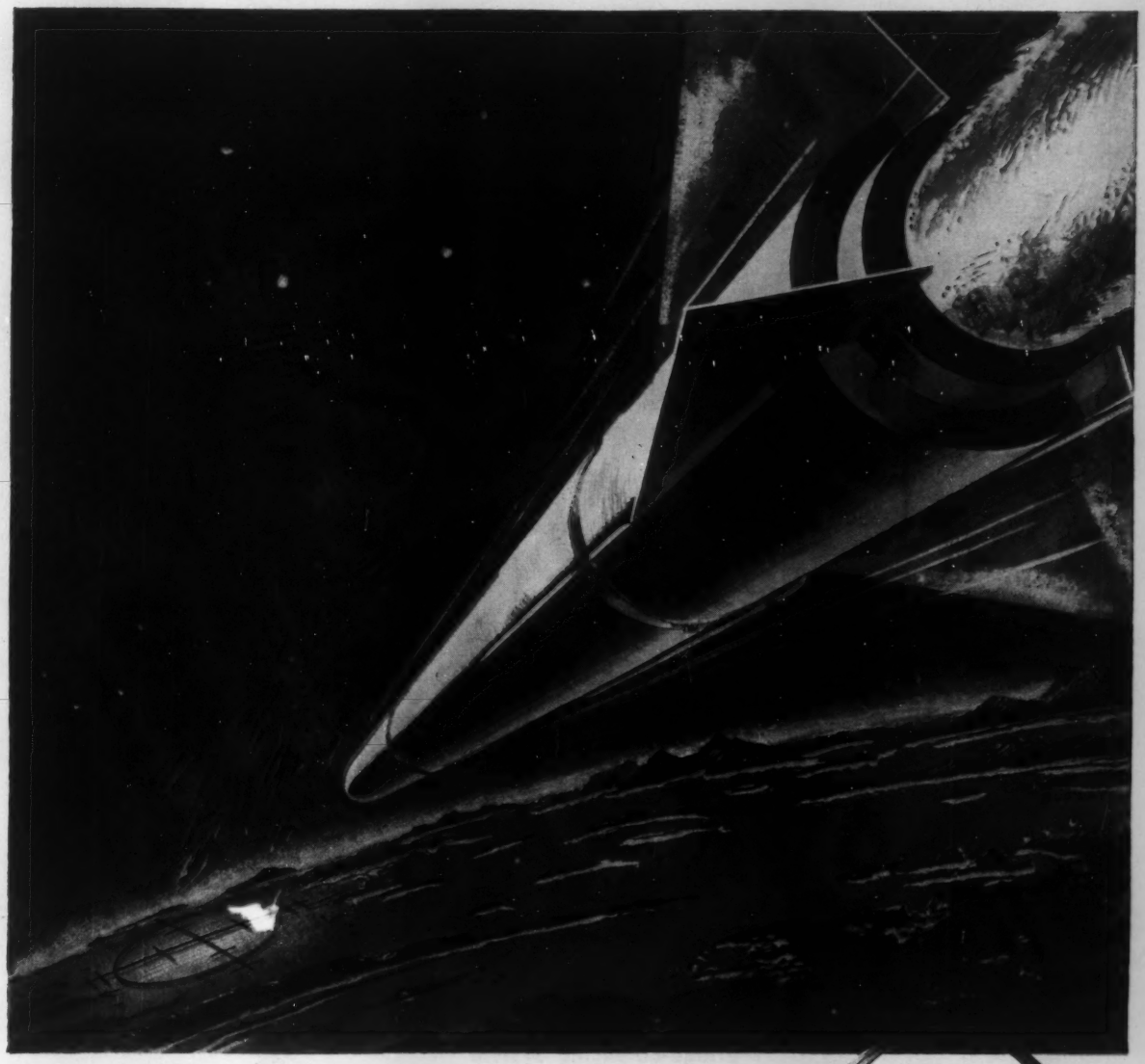
Circle 761 on Page 19

Templates

for drawing ferrous-flanged valves

No. 88 and 89 ferrous-flanged valve templates cover B16.10 valves for use in pipe systems of oil and chemical industries. Both templates contain sizes from 2 to 8-in. pipe diam in light and heavy series. They are of 0.030-in. thick plastic, with cutouts individually





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Write today. Let our engineering department demonstrate how Amweld can help you cut production costs on rings, bands and circular components.

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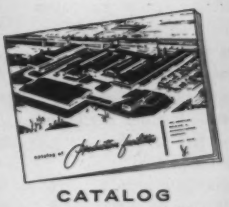

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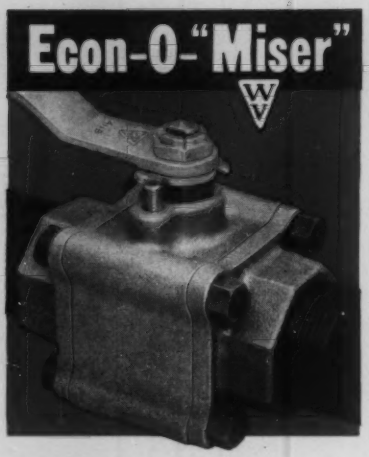
AMERICAN WELDING



Worcester's New Econ-O-"Miser" Ball Valve* is BOTH

VALVE and UNION

The costs of a union and installing it are eliminated. Add to this the longer operating life of the Econ-O-"Miser", the time and materials savings of *in-line maintenance*, and you get performance unmatched by *any* valve at *any* price.

The Econ-O-"Miser" is available in Bronze, Aluminum, Aluminum Bronze, Forged Carbon Steel, types 303 and 316 Stainless Steel. Seat and seal materials available: Teflon, Buna-N and Neoprene (others available on request.)

The many combinations of body and seat seal materials allow handling of exceptionally wide range of media.

Other Outstanding Features

- Compact for ease of installation
- Positive leakproof shut-off
- **In-line maintenance** permits quick, easy inexpensive repairs
- Two-way flow allows application of pressure or vacuum to either side of valve
- Quarter turn operation — readily adaptable to remote control
- Visual determination of OPEN — CLOSED positions — No manual check needed
- Round flow through the valve — minimum pressure loss and turbulence
- "Wiper-action" of resilient seat against ball eliminates abrasive wear due to foreign materials in media . . . assures leak-proof seal . . . long operating life

* Pat. Pending

Write for full particulars

WORCESTER VALVE CO., Inc.

18 Parker Street, Worcester, Mass.

Circle 571 on Page 19

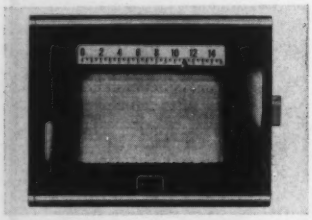
precision milled. Template No. 88 (shown) has scale of ⅜ in. to 1 ft; scale of the No. 89 is ¼ in. to 1 ft. **Rapidesign Inc.**, P. O. Box 429, Burbank, Calif.

Circle 762 on Page 19

X-Y Recorder

has standard accuracy of 0.25 per cent

Dynamaster X-Y strip-chart recorder automatically plots a continuous curve showing the relationship of one measured variable to another. Typical uses include plotting temperature versus pressure in process industries, position of intake parts versus gas flow in wind tunnel research, location on web versus thickness in paper



making, and speed versus torque in motor operation. Unit records on a 12-in. strip chart, and is available in pen speeds up to 0.4 sec for full scale traverse. Standard accuracy is 0.25 per cent. **Bristol Co.**, Waterbury 20, Conn.

Circle 763 on Page 19

Bridge-Balancing System

miniature system calibrates up to 24 transducer channels

Subminiature system is for use with strain gages, accelerometers, pressure, position, or other resistance-type transducers to control, balance, and automatically calibrate up to 24 transducer channels in ground or airborne applications. Four bridge-balance and calibrating units, which can be used alone for manual calibration or in groups with automatic calibrator and control, make up the system, and 6, 12, 18, and 24 channels are available for use. Sensitivity control of each channel is by a 500-ohm, 1½-w potentiometer with shaft lock. Separate switch, independent of potentiometer, is for on-off control without requiring change in

GEARS

Symbol of QUALITY

Industrial Gear offers a complete line of the finest cut gears available for the equipment of America. **Plus** — a combination of precision and quality, reasonable costs, and superb service.

INDUSTRIAL GEAR MFG. CO.

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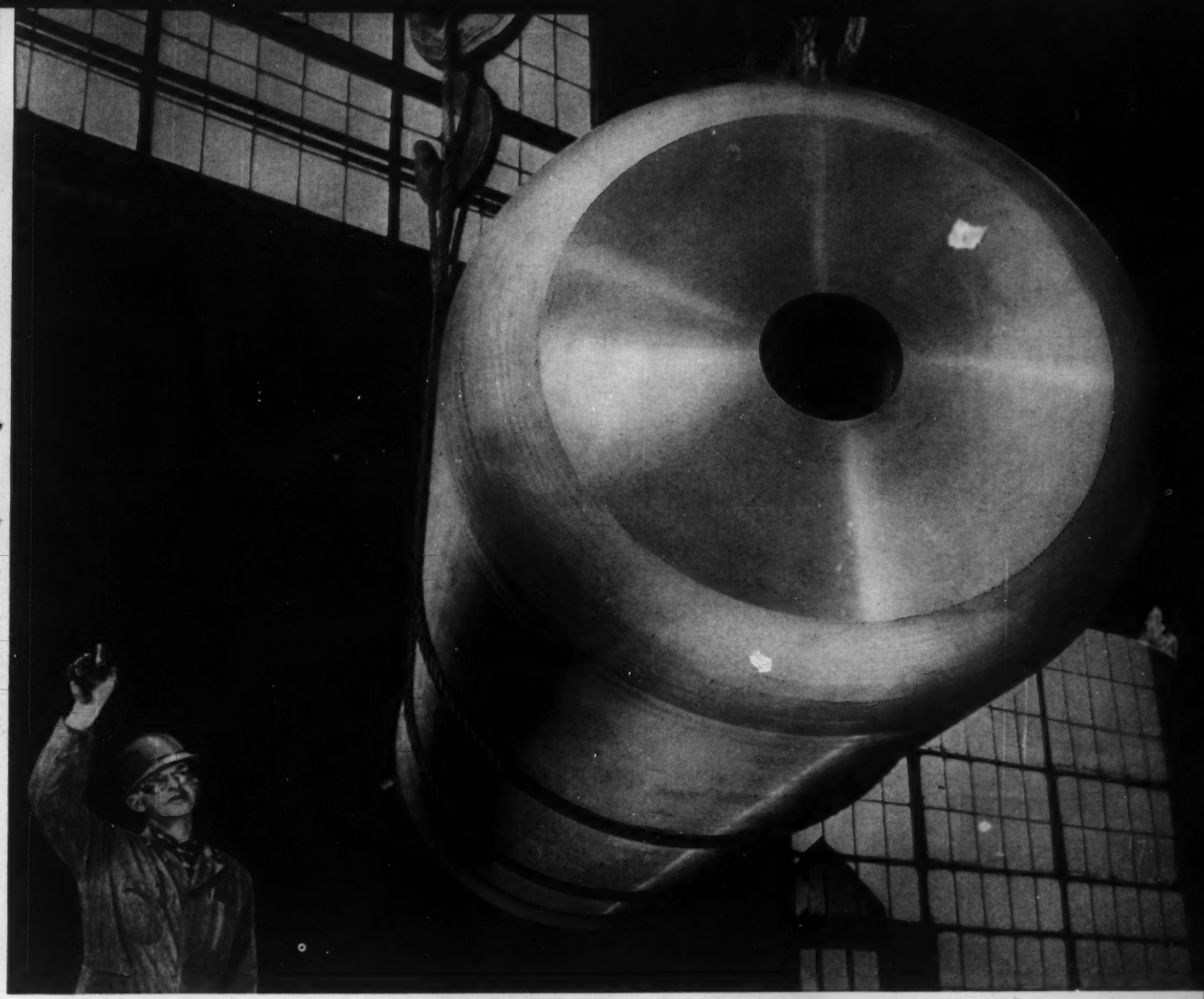
Chicago 24, Illinois

Circle 572 on Page 19



IT HAS A JOB
in one of the world's most spectacular machines

This forged-steel cylinder, one of four supplied by Bethlehem, was built for use in a king-size hydraulic jacking system. Sound rather prosaic? It isn't. The jacking devices are part of the leveling equipment in one of the world's most spectacular machines—the Marion 5760.

The 5760 is an electric power shovel so huge as to defy description. In working position the top of the boom is as high above ground as the roof of a 12-story building. Dipper capacity is 70 cu yd.

The cylinder forgings that Bethlehem furnished weigh 11½ tons each. They are 10 ft 3½ in. long. They have a maximum OD of 48 in. and a body OD of 45 in. In each case the diameter of the main bore is 35¼ in. These are big cylinders, rugged and strong—as they would have to be in a shovel of such giant proportions.

You yourself may never need forgings of this general nature. Perhaps your requirements run to smaller items, or something much larger. But no matter what the design, Bethlehem is always able to meet your specifications. Bethlehem's integrated set-up can produce all types of press, hammer, and closed-die forgings, and machine them as desired. When you are next in the market, we suggest you check fully with our engineers.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 573 on Page 19

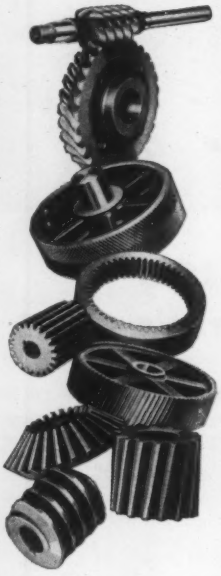
Gears with long useful lives . . .
the result of *high quality at H&S**

***Quality materials**
***Modern tooling**
***Superior workmanship**

Highly appreciated by the paper mill industry, for instance, are the large spur gears such as the one shown here. This gear has 140 teeth of 2 diametral pitch and 8″ face. It is being completed on a 100″ Fellows Gear Shaper that generates high quality external and internal spur gears up to 8″ face and 1½ D.P.

The modern Horsburgh & Scott plant is equipped with many new precision tools to meet today's demand for higher quality industrial gearing. You can judge our ability to serve you by these examples of size range:

Spur gears up to 156″ diameter
Helical gears up to 100″ diameter
Sykes Herringbone gears up to 60″ diameter
Bevel gears up to 77″ diameter
Worm gears up to 60″ diameter

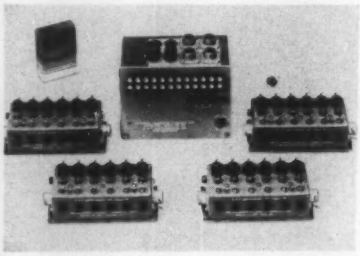


You benefit by the exacting care that we exercise in every manufacturing step. Tell us your requirements; quotations will be sent by return mail.

A request on your company letterhead will bring a copy of the new H&S Gear Catalog 57 to help you design and order industrial gears.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue
Cleveland 14, Ohio

Engineering Equipment



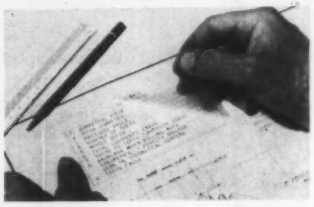
sensitivity setting. **B & F Instruments Inc.**, 4732 N. Broad St., Philadelphia 41, Pa.

Circle 764 on Page 19

Applique Material

adheres to drawing paper after long storage periods

Aplika material is a translucent plastic with a fine-grain surface that takes pencil, ink, or printing. As material makes contact with drawing paper, it becomes completely transparent. Use of a nonbleeding-type glue and special backing paper makes material adhere to drawing paper after long periods of storage. Material is available in sheet form with special backing in 6 x 9 and 8½ x 11-in. sizes. Sheets are plain or printed to any specifications. Material can



be printed by standard offset printing equipment, using quick-drying ink. **Transparent Products Co. Inc.**, Aplika Dept., 324 E. 24th St., New York 10, N. Y.

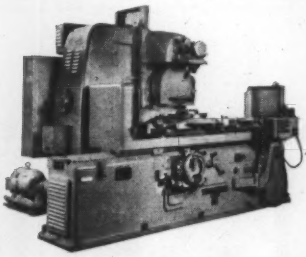
Circle 765 on Page 19

Battery-Operated Voltmeter

measures voltages from 1 mv to 300 v full scale

Type 10A battery-operated ac electronic voltmeter incorporates all-transistor design and printed wiring. Absence of drift caused by vacuum tube warm-up assures stable readings as soon as instrument is turned on. Unit measures voltages from 1 mv to 300 v full

Thompson Precision Surface Grinder, Type C

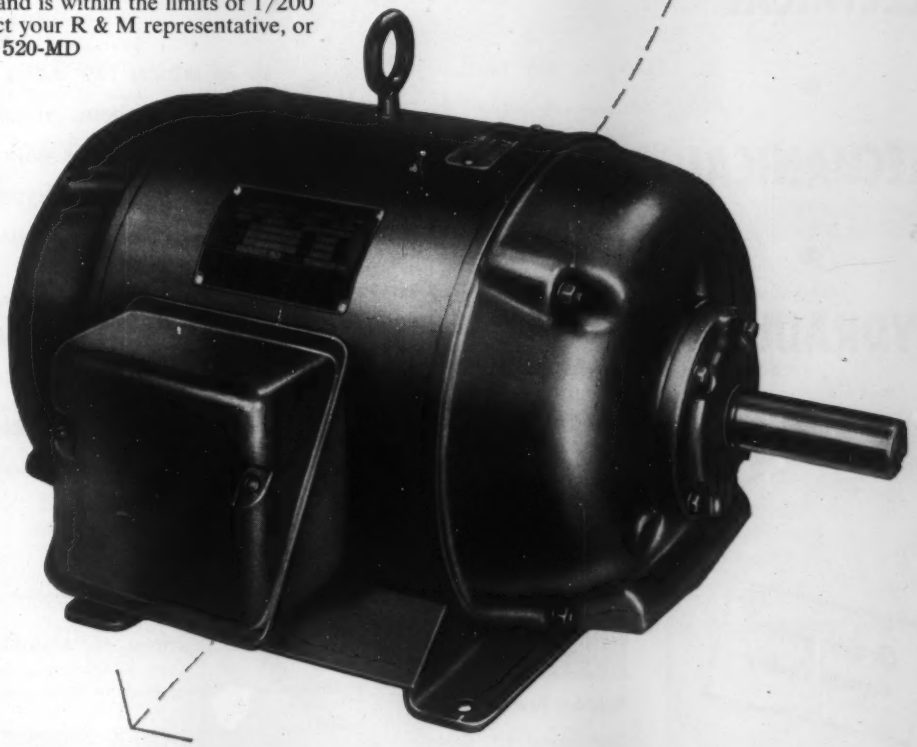


Thompson Grinders are world famous for accuracy. Their precision depends to a great extent, on the smooth running R & M hydraulic pump drive motors and the motor parts in the spindle head. Since even slight vibration in a precision machine tool destroys fine surface finish, Thompson engineers have wisely chosen R & M Motors because of dependability and running smoothness.

Freedom from vibration in a motor depends upon the physical balancing of moving parts and also the elimination of torque impulses set up in the windings. All R & M rotors are balanced to have less than .000025 inches of vibration amplitude and torsional vibration is eliminated by designing the windings for balanced magnetic symmetry.

If your application requires smoothness, dependable performance and is within the limits of 1/200 to 200 H.P. contact your R & M representative, or write for Bulletin **520-MD**

motor balance boosts Thompson precision!



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Circle 575 on Page 19

NOW in one book

. . . what the designer should know about . . .

ADJUSTABLE-SPEED DRIVES

. . . covers all the basic methods of adjustable speed!

by

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". . . the most comprehensive design guide on Adjustable-Speed Drives available *anywhere*"

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MECHANICAL

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HYDRAULIC

Here, in *one* book—148 pages, with 24 tables, 119 charts and 171 illustrations—is what the designer should know about adjustable speed. It contains the entire co-ordinated program of articles which appeared in MACHINE DESIGN on main drive and transmission types—electric-motor, slip-coupling methods, mechanical drives, and hydraulic drives.

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scale, within frequency range of 20 cycles to 500 kc. Large meter swing enables voltage differences as small as 0.5 per cent to be detected. **Consolidated Electrodynamics Corp.**, Alectra Div., 325 N. Altadena Drive, Pasadena, Calif.

Circle 766 on Page 19

Oscilloscope

for general-purpose use has 5-in. screen

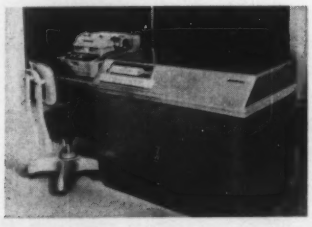
Model 466 Handiscope is a small, general-purpose unit. It has a 5-in. screen, filter-type graticule, and universal-fit bezel. Applications include industrial maintenance and production testing, and servicing radio, phonograph, and general communications equipment. **Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

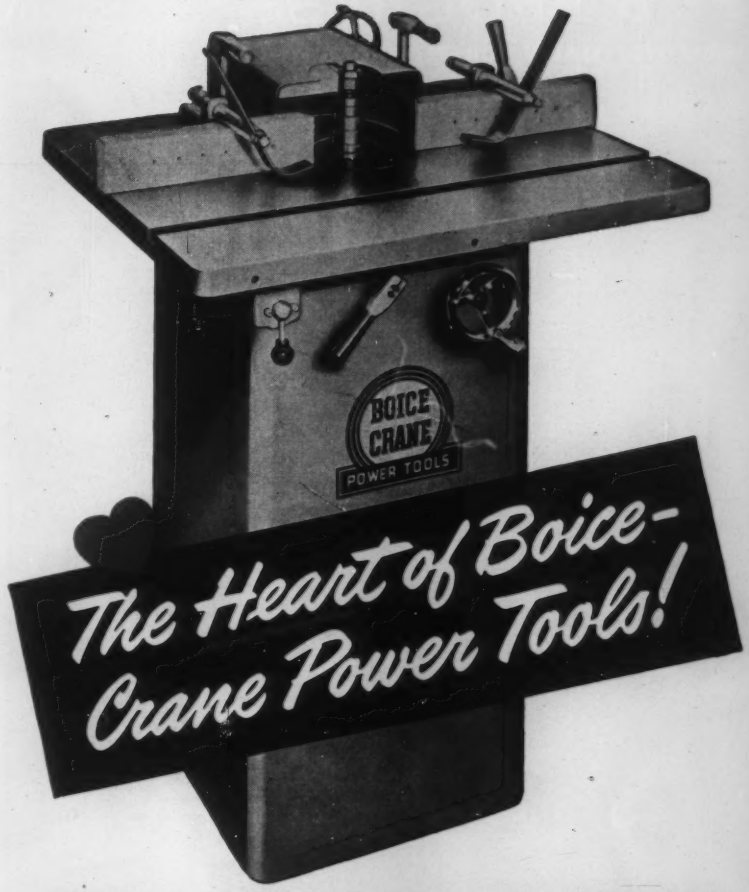
Circle 767 on Page 19

Electronic Computer

has 4096-word capacity

LGP-30 is a serial, single-address, fixed-point, binary, stored-program digital computer. It has a memory drum capacity of 4096 words. Word length is 32 bits, including sign and spacer bit. Unit contains 34 etched-circuit cards of 12 different types, easily removable for maintenance. Although the computer has a large memory capacity, it is a small, desk-sized unit. A universal computer, it can be used for many research and applied engineering applications. Unit





BALDOR STREAMCOOLED MOTORS

For years famous Boice-Crane Power Tools have enjoyed a reputation for faultless performance. And for years, like hundreds of other leading manufacturers, Boice-Crane has specified and depended on Baldor Streamcooled Motors to maintain its enviable prestige.

If customers demand this kind of superior performance from *your* equipment, it will pay you to consult Baldor. Experienced engineers are available to help take the kinks out of all your knotty motor problems . . . *without obligation!*

Rear view of Boice-Crane Spindle Shaper showing vertical installation of Baldor Streamcooled Motor.

Write for Catalogs on Complete Line!

Baldor ELECTRIC CO.

4353 Duncan Ave. St. Louis 10, Missouri

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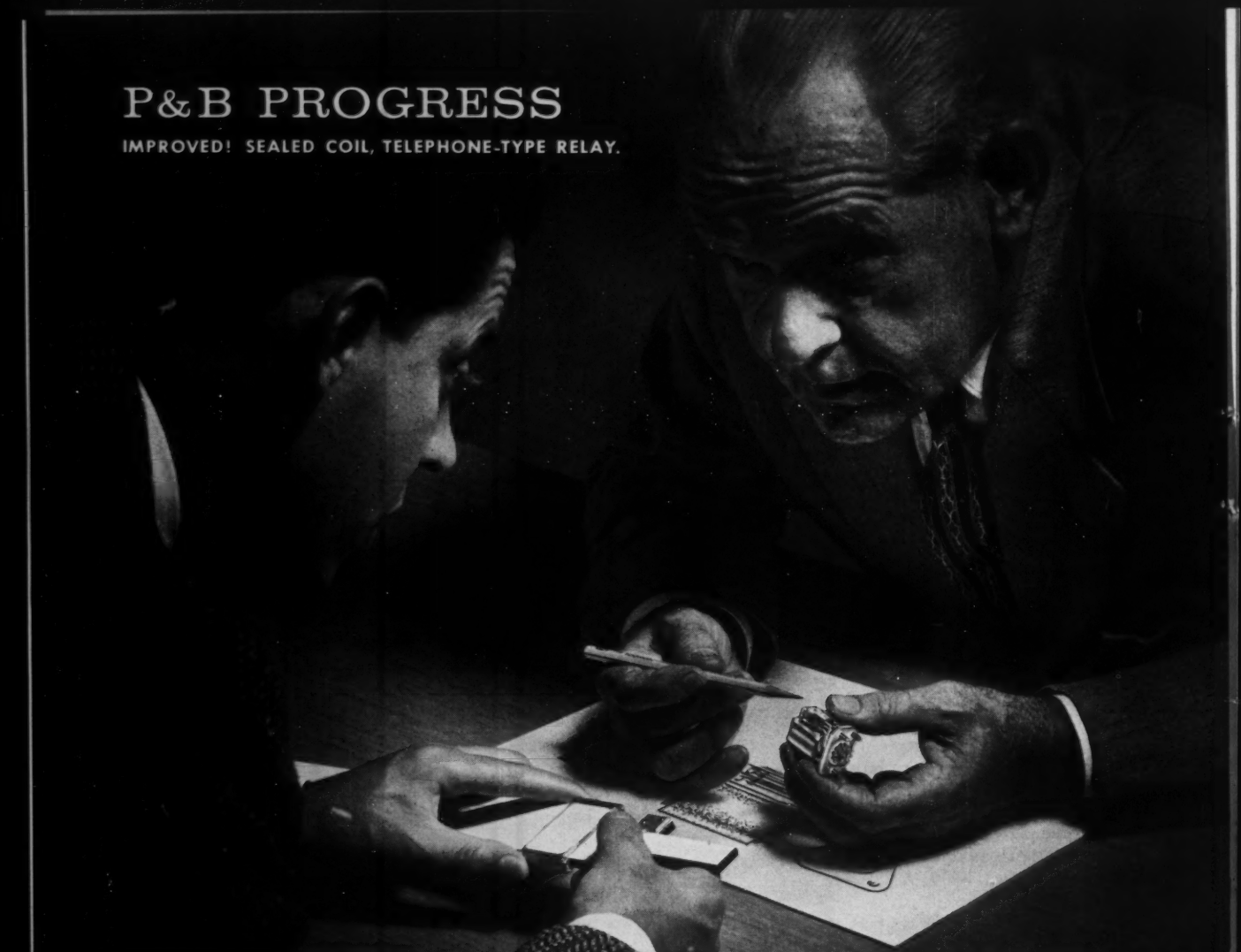
P&B PROGRESS

IMPROVED! SEALED COIL, TELEPHONE-TYPE RELAY.

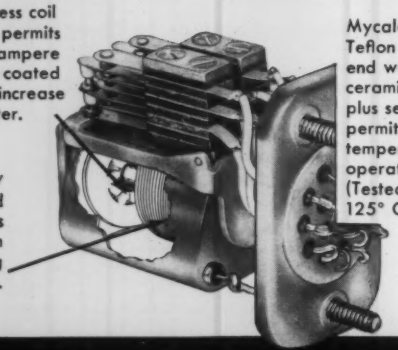


NEW! DUAL HERMETIC SEAL INCREASES RELAY RELIABILITY AND TEMPERATURE RANGE

LOOK AT THESE GREAT NEW FEATURES

New bobbinless coil saves space, permits use of more ampere turns of Teflon coated wire with no increase in coil diameter.

Hermetically sealed coil prevents gases from contaminating contacts.



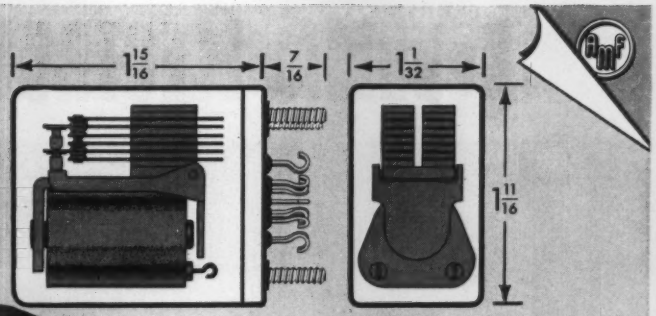
Mycalex stack, Teflon wire and end washers and ceramic pushers, plus sealed coil, permit high temperature operations. (Tested up to 125° C.)

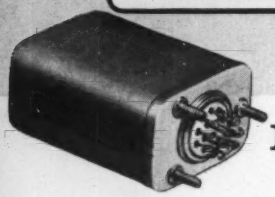
Hermetically sealing the coil of the MH "Seal-Temp" substantially increases the reliability and life of this popular telephone-type relay. Considered a major reason for relay failure, contact contamination due to outgassing of the coil has been eliminated by this sealing process.

The "Seal-Temp" has a temperature range considerably broader than ordinary relays... from −65° C to +125° C. This is achieved by constructing the stack of Mycalex, employing ceramic pushers, and by using Teflon coated wire throughout.

For applications where reliability, long life and broad temperature ranges are required, the MH "Seal-Temp" relay could well be the answer. Write, wire or call today for complete information.

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA / SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY





MH "SEAL-TEMP" RELAY

GENERAL: Insulating Material: Ceramic, Mycalex and Teflon.
Insulation Resistance: 1,000 meg ohms min.
Breakdown Voltage: 500 V. RMS.
Shock: 30g's.
Vibration: 5g's 55 to 500 cps.; .032" max. excursions 5-55 cps.
Temperature Range: −65° C to +125° C.
Pull-In: Approximately 75% of nominal voltage at 25° C.
Terminals: Miniature plug in; hook end solder.
Enclosure: Short "M" Can, hermetically sealed.

CONTACTS: Arrangements: Up to 6 springs per stack. (4PDT)
Material: ⅛" Silver (others available).
Load: 5 amp. 115V. AC resistive.

COILS: Resistance: Up to 22,000 ohms.
Power: 100 mw per movable arm min.; 4 watts max. DC at 25° C. (200 mw min. to meet shock or vibration requirement at 25° C.)
Duty: Continuous.
Insulation: Teflon.
Coil Chamber: Hermetically sealed.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc.

PRINCETON, INDIANA

SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.

Mail the coupon for complete engineering data on the new MH Series, plus new compact catalog of standard type relays. If you need answers to a specific application problem write in detail.

Potter & Brumfield, Inc., Princeton, Indiana
Attn: T. B. White, Brig. Gen. USMC (Ret.)
Special Projects Engineer

Please send me complete engineering data on the new MH Series Relay plus the new compact catalog of P&B standard relays.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

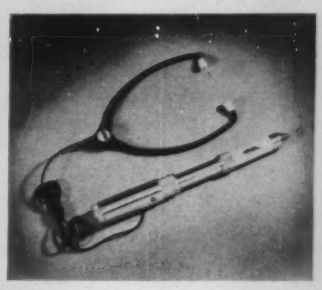
Circle 578 on Page 19

operates on 115 v, 60 cycle, single-phase line. **Royal McBee Corp.**, Westchester Ave., Port Chester, N. Y.

Circle 768 on Page 19

Sound Detector

discloses internal sounds in machinery and components

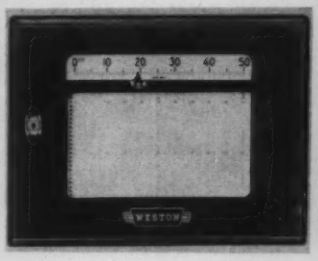


Venco Detecto-Scope, an aluminum, transistorized, battery-powered unit, discloses internal sounds in bearings, motors, gear trains, pumps, and turbines. Unit has excellent sensitivity and range of application. Flow of liquid through pumps or pipes can be detected, as well as the smoothness of tooth mesh in gear trains. **Valley Engineering Corp.**, 15th and Elm St., Easton, Pa.

Circle 769 on Page 19

Multipoint Recorder

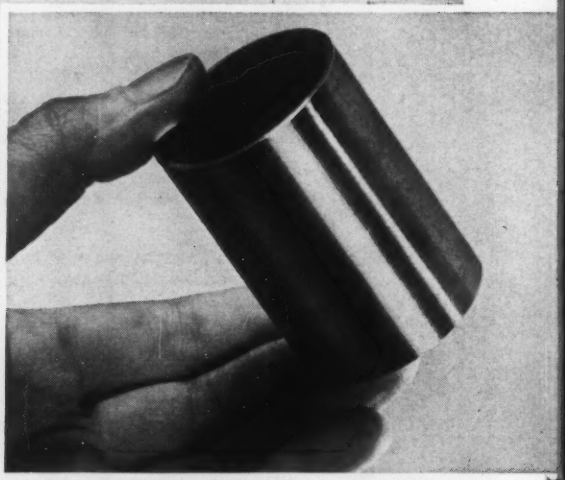
in small size case



Model 6702 multipoint strip chart offers up to 12 points on a full-size strip chart, in a small size case. Incorporated into the design are easy range change, simple chart speed change, and unitized construction. Also available are a circular chart recorder and a four-pen mechanical recorder. **Weston Electrical Instrument Corp.**, Div., Daystrom Inc., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle 770 on Page 19

Republic ELECTRUNITE



WHEN IT'S MOVING, MAKE IT TUBING . . . a Republic engineering principle that improves sales and profits for manufacturers. This simple 2½-inch bearing liner made of Republic ELECTRUNITE Stainless Steel Tubing is featured in the new "Highlander" Automatic Washer developed by the Maytag Company to meet the needs and requests of budget-conscious young Americans.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Stainless Steel Tubing... helps MAYTAG bid for Big Volume Sales

Engineering innovations such as this switch to Republic ELECTRUNITE® Stainless Steel Tubing made it possible for the Maytag Company to produce its new "Highlander". This automatic washer is priced to meet the needs and demands of budget-conscious young Americans without sacrificing quality found in top-of-the-line models.

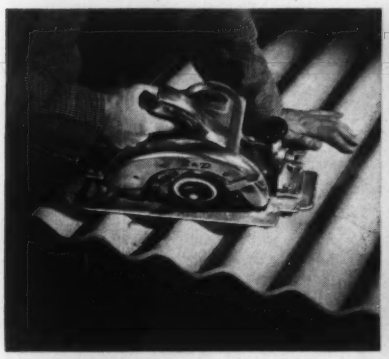
It's a simple 2½-inch bearing liner. But, it saves Maytag money.

Republic ELECTRUNITE Stainless Steel Tubing provides greater true concentricity than the tubing formerly used. There is no need for buying a heavier wall and then spending more money to remove stock.

Tubing originally purchased was .187″ wall thickness. By utilizing the concentricity of ELECTRUNITE they were able to reduce the wall to .083″.

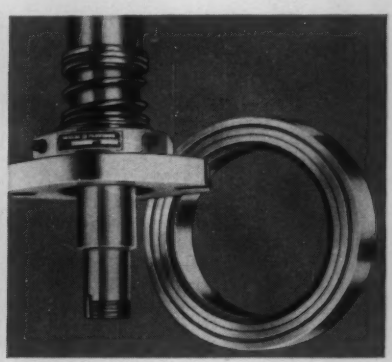
And, they get the rust-and-corrosion-resistance that only stainless steel can offer. This is vital because the tube becomes the outer shell of the main agitator bearing. It must operate for the *life of the washer* with no further lubrication than originally supplied.

Welded stainless steel tubing can save you money and hold quality high. Especially when it's ELECTRUNITE—uniformly round, uniform in wall thickness, free from defects, resistant to rust and corrosion, easily fabricated, strong, tough. And, produced by Steel and Tubes—the pioneer in electrically welded tubing. Let us show you where it can cut costs, improve quality in your products, processes and plants. Write for additional information today.



HEAVY-DUTY PERFORMANCE and reliability have played a major part in establishing product reputation for The Black & Decker Manufacturing Company, Towson, Maryland. Strong, long-lasting gears made from Republic Cold Finished Alloy Steel meet the heavy duty service requirements in this Black & Decker portable electric saw. And exceptionally high strength-to-weight ratio permits design of thinner sections to save weight and hold down size without sacrifice of strength. These are but a few advantages Republic Cold Finished Alloy Steel may offer you in your operations. For complete details write today.

REPUBLIC ELECTRO PAINTLOK, used for these water cooler housings, or for exterior panels of ranges, freezers, dryers, washers, air-conditioners and other major appliances and cabinets for home, commercial and industrial applications, provide an excellent paint-gripping surface for greater finish economy. Produced by electro-galvanizing and a chemical treatment process, Electro Paintlok Sheets are shipped from the mill in prime condition for painting. Even if final finish is scratched through, this coating limits corrosion to the point of damage. For additional data and complete details, send coupon.



REPUBLIC ENDURO® STAINLESS STEEL BARS develop a machine finish that looks as good as a ground finish—is the performance report from machine operators at Sealol Corporation, Providence, Rhode Island. This company used Free-Machining ENDURO bars in the manufacture of mechanical shaft seals for applications on fuel tankers, and in the food, chemical, aircraft and petroleum industries. Sealol machine operators like the machinability of ENDURO Stainless Steel Bars—the fine surface finish, the accuracy of section, the uniform soundness, and the ability of ENDURO to hold close tolerances. Send coupon today.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-4634
3130 EAST 45TH STREET • CLEVELAND 27, OHIO

Please send additional information for the following:

- ☐ Republic ELECTRUNITE Stainless Steel Tubing
- ☐ Republic Cold Finished Alloy Steel
- ☐ Republic Electro Paintlok
- ☐ Republic ENDURO Stainless Steel

Name_____ Title_____

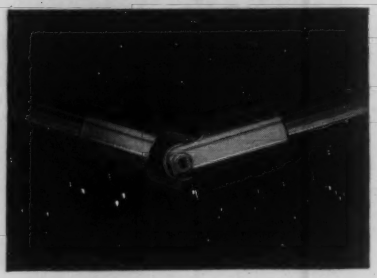
Company_____

Address_____

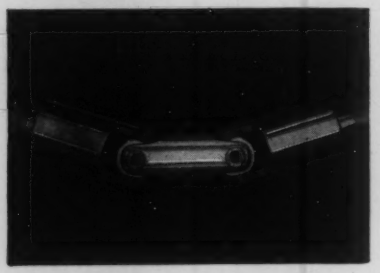
City_____ Zone____ State_____

Circle 579 on Page 19

How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

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Circle 580 on Page 19

THE ENGINEER'S Library

Recent Books

An Introduction to Fluid Mechanics and Heat Transfer. *By J. M. Kay, Imperial College of Science and Technology, University of London; 309 pages, 5½ by 8½ in., clothbound; published by Cambridge University Press, 32 East 57th St., New York 22, N. Y.; available from* MACHINE DESIGN, *$7.00 postpaid.*

Main emphasis of this book is on fundamental ideas of fluid flow, viscosity, heat conduction, diffusion, energy and momentum principles, and dimensional analysis. Ideas are developed in terms of practical application wherever possible.

Equations of fluid motion, turbulence, and forced convection are also discussed. Aspects of fluid flow and heat transfer are covered from the point of view of mechanical process engineering.

Fads and Fallacies in the Name of Science. *By Martin Gardner; 363 pages, 5½ by 8 in., paperbound; published by and available from Dover Publications Inc., 920 Broadway, New York 10, N. Y.; $1.50 per copy.*

This study in human gullibility will provide amusing diversion for those interested in the origin and history of fads and fallacies which at one time or another have masqueraded as science. Containing no formulas, theories, or diagrams, the book presents commentaries on various plausible-sounding theories. Subjects range from indisputable facts proving the earth flat, to a brand-new examination of Bridey Murphy.

Concise Guide to Plastics. *By Herbert R. Simonds; 318 pages, 6 by 9 in., clothbound; published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.; available from* MACHINE DESIGN, *$6.95 postpaid.*

This book is a complete guide to all known American commercial

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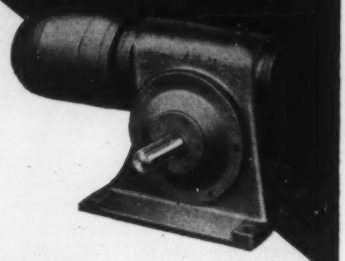

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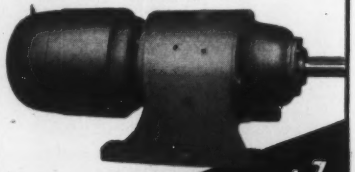

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Circle 581 on Page 19

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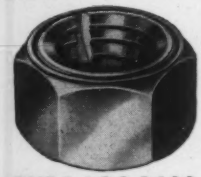

DURA-LOC 1600
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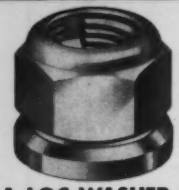

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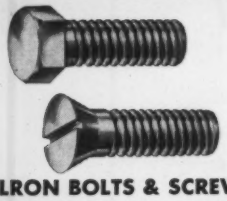

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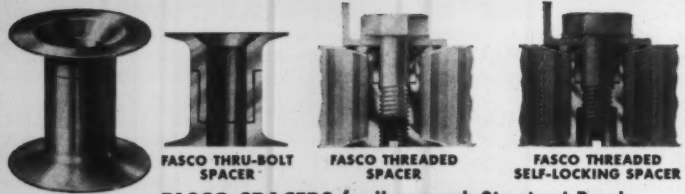

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plastics, including those still in the laboratory stage. It instructs in the selection, use, and forms of plastics, and discusses which ones are best for particular applications.

Included are basic data on strength, properties, processes, production, and prices. A special index lists 43 of the most important plastics producers with addresses, personnel, products, tradenames, and operations.

Future trends and probabilities in plastics are also discussed, together with newest production methods.

Behavior of Metals at Elevated Temperatures. *122 pages, 5½ by 8½ in., clothbound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; available from* MACHINE DESIGN, *$6.00 postpaid.*

This volume contains the full text and illustrations of lectures delivered at the Institution of Metallurgists in London, England, in 1956.

Temperature effects on engineering properties of metals from room temperature to the highest working limits are fully treated. Stability of physical properties, elastic constants, coefficients of expansion, resistance to plastic deformation and fracture under stress, and behavior under fluctuating temperatures are also discussed.

Other topics include principles to be followed in developing alloys with good mechanical properties, and a comparatively new subject, kinetic heating.

Strength of Materials. *By F. R. Shanley, University of California; 783 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.50 postpaid.*

This book does not emphasize particular fields of structure, but contains material which forms the basis for all types of structural analysis and design. Principles of statics are reviewed early in the book and are extended to include two-dimensional force fields.

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Circle 584 on Page 19

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tures are treated, and experimental aspects of strength of materials are omitted entirely except for brief references.

Considerable emphasis is placed on direct use of curves and on problem solution by means of tabular computation forms. Major topics include inelastic column theory, buckling of thin plates and shells, and applications of the moment-distribution method for solution of statically indeterminate structures.

Transistor A. F. Amplifiers. *By D. D. Jones and R. A. Hilbourne;* 152 *pages,* 8½ *by* 5½ *in., clothbound; published by Philosophical Library Inc.,* 15 *East* 40*th St., New York* 16, *N. Y.; available from* MACHINE DESIGN, $6.00 *postpaid.*

This book presents a systematic treatment of the design of transistor audiofrequency amplifiers and gives circuitry and design details of a versatile range of amplifiers. Material treats mainly of the p-n-p germanium type transistor.

Included are explanations of how to overcome main problems of designing input stages with high signal-to-noise ratio and output stages with maximum efficiency and minimum distortion. Methods of applying negative feed back and of manually controlling gain and frequency response are also discussed.

Design details of five circuits with outputs ranging from 1 to 20 w show practical applications of theoretical considerations.

Association Publications

Investment Casting Engineering and Design Manual. 50 *pages,* 8½ *by* 11 *in., paperbound; available from Investment Casting Institute,* 27 *East Monroe St., Chicago* 3, *Ill.;* $5.00 *per copy.*

This book is intended as a practical guide to investment casting for design engineers and metallurgists. Many characteristics of the process are presented. Generalities are avoided, and specific information is given concerning the solution of design problems.

Both the "lost-wax" and frozen-mercury processes are discussed.

Circle 585 on Page 19

Circle 586 on Page 19→

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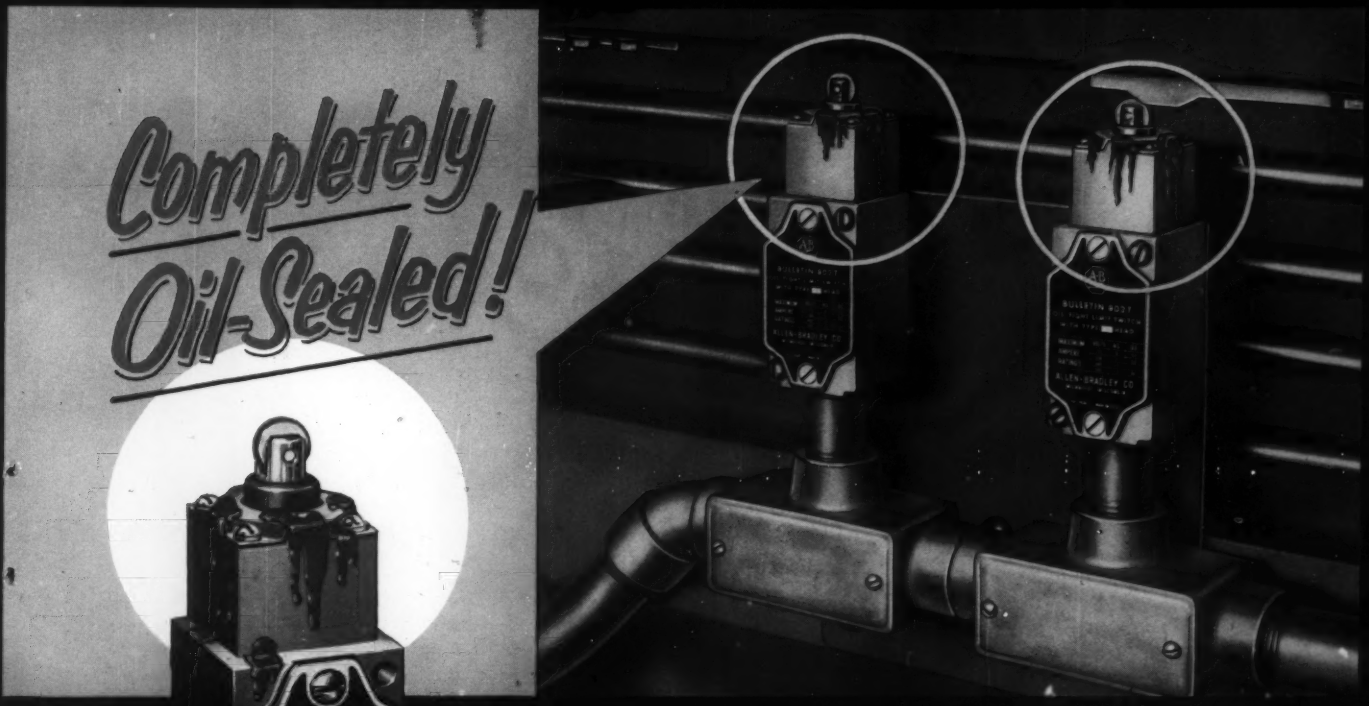

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Design particulars include surface finish, dimensional tolerances, radii, concentricity, angles, parallel sections, threads, airfoils, and general notes on cores.

Fatigue Properties of Cast and Comparable Wrought Steels. *By E. B. Evans, L. J. Ebert, and C. W. Briggs; 32 pages, 6 by 9 in., paperbound; available on letterhead request from Steel Founders' Society of America, 606 Terminal Tower, Cleveland 13, Ohio.*

This booklet is a preprint of *Proceedings of the American Society for Testing Materials.* It is intended for designers as an aid in selecting either cast or wrought steels for particular applications. Included are physical and mechanical properties of both materials, charts, tables, and other data.

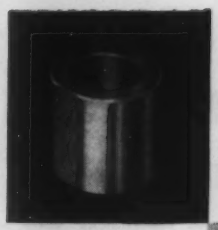
Fatigue Durability of Carburized Steel. *123 pages, 6 by 9 in., clothbound; published by and available from the American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio; $4.00 per copy.*

This book is a compilation of lectures presented by members of the General Motors Research Staff to the ASM during the National Metal Congress and Exposition in 1956.

Five major sections cover topics essential in effective application of carburized steel to critical components. Included are effects of surface conditions on fatigue resistance of hardened steel, residual stresses and fatigue durability in carburized steel, and physical and metallurgical properties. A special three-page bibliography contains many literature references.

Proceedings of the Third Annual Computer Applications Symposium. *148 pages, 6 by 9 in., paperbound; available from Armour Research Foundation of Illinois Institute of Technology, 10 West 35th St., Chicago 16, Ill.; $3.00 per copy.*

A primary purpose of the conference was to illustrate diversity among medium-scale computing machines and their applications. The proceedings record the exchange of ideas and experiences



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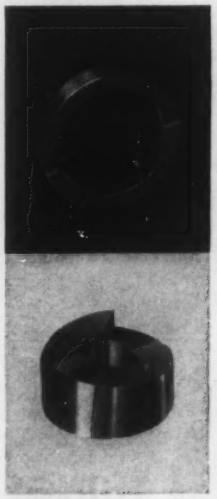

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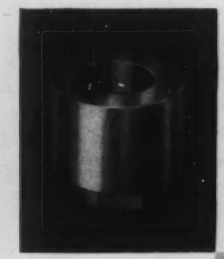

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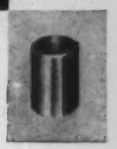

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Circle 587 on Page 19

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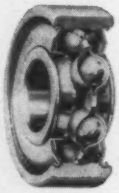
Now Available with ABEC-1 Tolerances



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Circle 589 on Page 19

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Reports of computer application cover problems in electrical machinery operation, training and research, optics, personnel classification, manufacturing data processing, and general programming. A special table summarizing characteristics of many types of computers is also included.

Welding Handbook. *Edited by Arthur L. Phillips; 560 pages, 6 by 9 in., clothbound; published by and available from American Welding Society, 33 West 39th St., New York 18, N. Y.; $9.00 per copy.*

This fourth edition of the welding handbook has been divided into five major sections for ease of reference. New sections will be published each year as a means of keeping welding information up-to-date.

Major topics include standard welding forms and definitions, engineering tables of conversion factors and metallurgical information, welding fundamentals, properties of welded joints, thermal and mechanical treatment of metal, economics of welding, inspection and standard weld tests, safety practices, and design techniques.

Manufacturers' Publications

Servosystems Laboratory Manual. *32 pages, 8½ by 11 in., paperbound; available from Educational Services Dept., Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N. Y.; $2.00 per copy.*

This manual was designed for use in industrial training programs in which equipment for laboratory experiments is limited. It provides a framework for an introductory laboratory course in servomechanisms, feedback-control systems, and closed-loop systems. Companies which find it necessary to train technicians for laboratory

work will find the manual useful.

Theoretical discussions are kept to a minimum, and practical applications are emphasized by means of simple experiments. Each experiment is built on the preceding one and aims at "breadboarding" basic servosystems.

Alcoa Aluminum Bus Conductor Handbook. 296 *pages,* 5½ *by* 8½ *in., clothbound; published by and available on letterhead request from Aluminum Co. of America,* 793 *Alcoa Bldg., Pittsburgh* 19, *Pa.*

This handbook deals with properties and uses of aluminum bus conductors. Major topics include properties of aluminum as bus material, bus conductor shapes and design factors, conductor current-carrying capacities and reactance, design factors of bolted and clamped joints, and joining practices. Illustrations and conversion tables are also included.

RCA Transistors and Semiconductor Diodes. 23 *pages,* 8½ *by* 11 *in., paperbound; available from RCA Commercial Engineering,* 415 *South* 5th *St., Harrison, N. J.;* 25 *cents per copy.*

This booklet contains a general explanation of transistor theory and operation, with a special section on the RCA developed drift-type transistor. Complete characteristic data on the 18 RCA types of transistors and four semiconductor diodes are supplemented by equivalent circuits and dimensional outlines.

Also included are circuit diagrams of 20 applications of transistors and diodes, and an interchangeability directory.

Transistor Manual, 2nd Edition. 112 *pages,* 5½ *by* 8½ *in., paperbound; available from Section PRR, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.,* 50 *cents per copy.*

This revised edition contains basic information on transistors and their application in electronic circuits. Application section of the manual has been expanded, and circuit diagrams for nearly thirty different pieces of equipment are

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included.

Also included are construction techniques, transistor specification symbols now in common use, and specifications with outline drawings of all transistors registered with the Electronic Industries Association (formerly RETMA).

Dimensions of the Human Figure. *By Lloyd W. Sahley; 34 pages, 8½ by 11 in., paperbound; published by and available from Cleveland Designers and Consultants Inc., P. O. Box 3989, Shaker Square Sta., Cleveland 20, Ohio, $1.00 per copy.*

This booklet contains human dimensions which are pertinent to design of machines, equipment, products, or tools. Illustrated charts show average dimensions of male and female figures, normal deviations, and minimum and maximum range of each. Application of dimensions may be made to design of control consoles, for example, in which instrument clusters can be located for most efficient operation.

Government Publications

The Properties of Constructional Metals as a Function of Temperature and Strain Rate in Torsion, WADC Technical Report 56-216 PB121912. *Prepared by Syracuse University; 186 pages, 8¼ by 10¾ in., paperbound; published by Wright Air Development Center; available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $4.00 per copy.*

This report presents results of testing seven structural metals: 4340 steel; type 321 stainless steel; 75S-T6 aluminum; AZ-31 magnesium; titanium, Rockwell C 70; and titanium 130 B; in torsion at various strain rates and temperatures. Both solid and tubular specimens were tested.

Materials-Property-Design Criteria for Metals, WADC Technical Report 55-150, Part 4: Elastic Moduli: Their Determination and Limits of Application, PB121857. *By S. A. Gordon, R. Simon, and W. P. Achback, all of Battelle Memorial Institute; 18 pages, 8¼ by 10¾ in., paperbound; published by Wright Air Development Center,*

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This report presents results of a study of the modulus of elasticity at elevated temperatures for several materials as it is derived from conventional stress-strain curves and as derived from velocity of propagation of elastic waves. Modulus values in regions of high and low-stress levels are given for both methods of determination.

U. S. Atomic Energy Commission Technical Reports. *Each publication is 8 by 10¼ in., paperbound, and stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

MLM-858. The Preparation of Plastics and Metallic Absorbers. 17 *pages;* 10 *cents per copy.*

ISC-305. Temperature Dependence of Electrical Resistivity of Metals. 83 *pages;* 50 *cents per copy.*

ISC-356. Correlation of Vickers Hardness Number, Modulus of Elasticity, and the Yield Strength for Ductile Metals. 28 *pages;* 20 *cents per copy.*

CRD-A19-27, Part 4. Materials Handbook—Properties of Titanium. 60 *pages;* 40 *cents per copy.*

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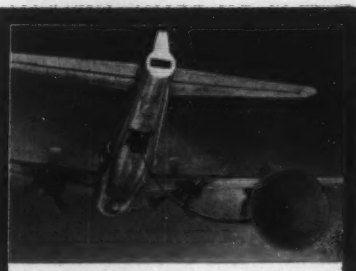
COO-202. High Density Graphite. 70 *pages;* 45 *cents per copy.*

BMI-89. The Properties of Thorium Alloys. 93 *pages;* 50 *cents per copy.*

AECD-3843. Technical Papers of the Sixth Metallographic Group Meeting, Held at Columbia University, September, 1952. 177 *pages;* $1.00 *per copy.*

AECD-3696. The Tensile Strength of Brazed Stainless Steel Joints. 15 *pages;* 20 *cents per copy.*



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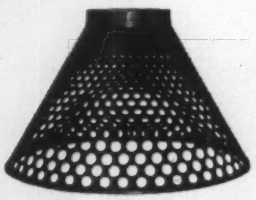

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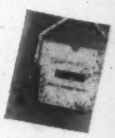

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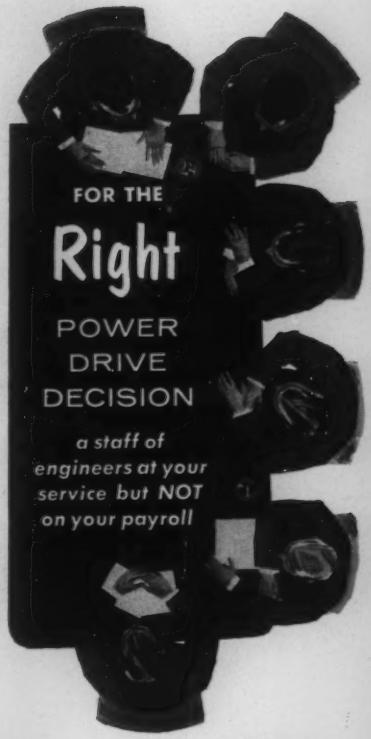

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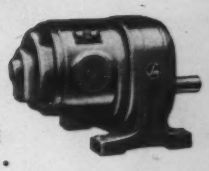

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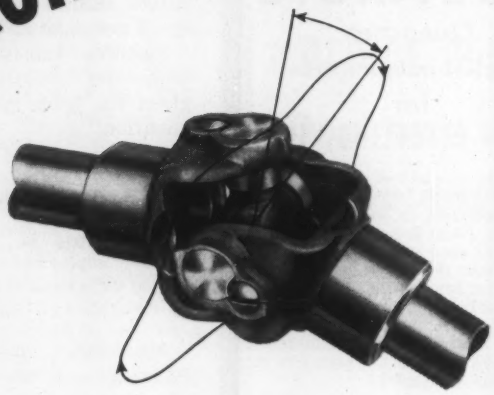

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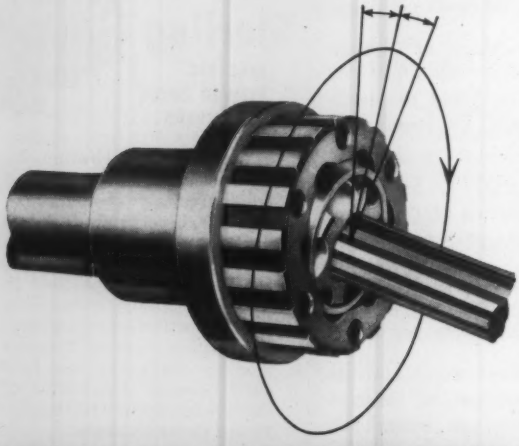

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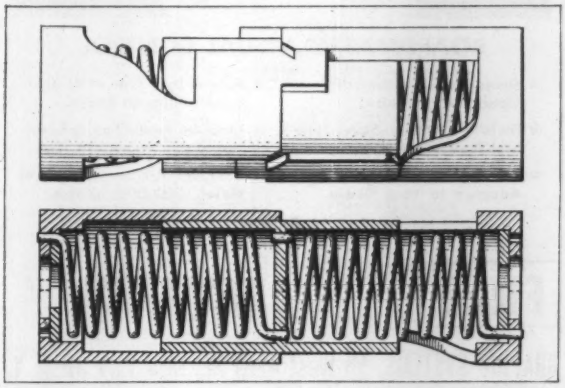
NOTEWORTHY

Patents

Adjustable-Gradient Spring Cartridge

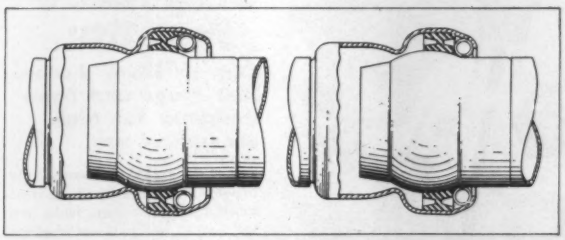
Axial components of spring compressive and torsional stiffness are summed to give a wide variety of force vs. deflection characteristics in an adjustable-gradient spring cartridge. Under an external load,



telescoping cartridge housings simultaneously twist and compress a pair of oppositely wound helical springs contained within the unit. Ratio of twisting to axial movement is controlled by the angle of cam surfaces cut in the housings. Result is to give a spring-cartridge gradient that can be programmed to suit the special demands of an application. *Patent* 2,807,-458 *assigned to General Electric Co. by Hugh M. Stephenson.*

Quick-Disconnect Coupling

Pipe-string sections can be quickly joined by a bell-and-ball coupling designed for use with either suction or pressure lines. Under suction conditions (left),



the ball seats firmly against an annular restriction in the female member, establishing correct axial relationship between coupling parts. When the pipe is pressurized (right), coupling members are interlocked by a helically wound garter spring. Fluid tightness under either suction or pressure is insured by a double-lipped synthetic seal. Bell-ball construc-

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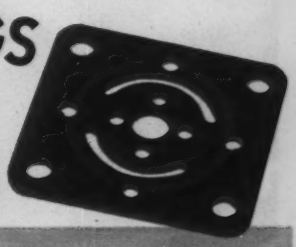

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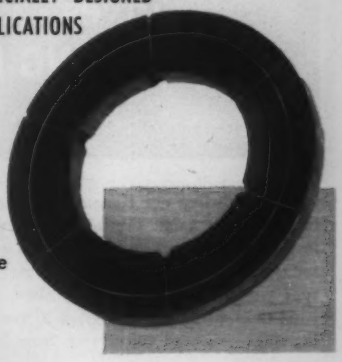

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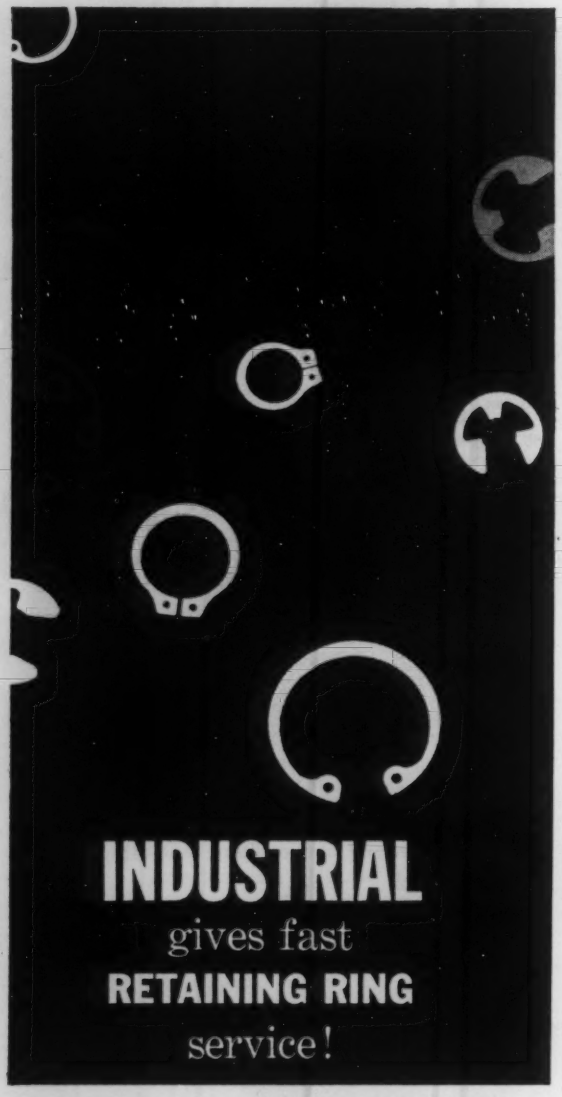

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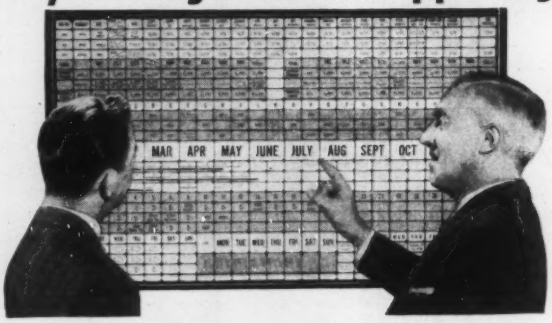

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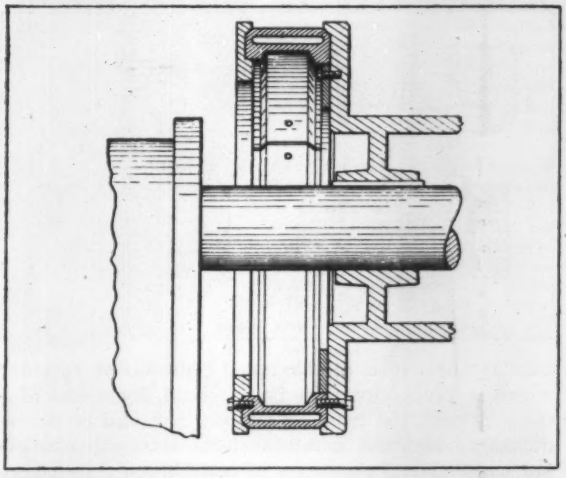
Circle 597 on Page 19

tion accommodates possible angular misalignment of connected pipe sections. *Patent* 2,808,275 *assigned to W. R. Ames Co. by Roger M. Sherman.*

Fluid-Cooled Brake Drum

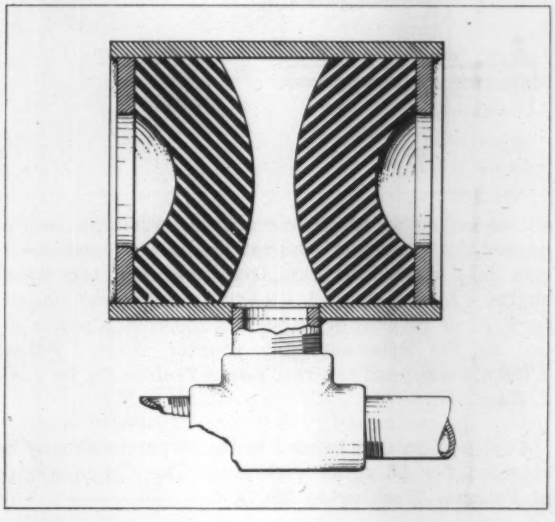
To facilitate disassembly without removal of the shaft, a fluid-cooled brake drum is made up of separately removable, hollow-cored drum sections. In-



dividual sections, which are bolted to the drum-support flange, are interconnected by flexible tubing to permit circulation of the cooling fluid. Typical applications are in hoist or winch installations. *Patent* 2,808,134 *assigned to Esso Research and Engineering Co. by Douglas Ragland.*

Surge Chamber

Fluid-line pressure pulsations are damped by distortion of a shaped rubber cylinder in cushion-dome surge chamber. Because distortion stresses are distributed throughout the volume of the shock-absorb-



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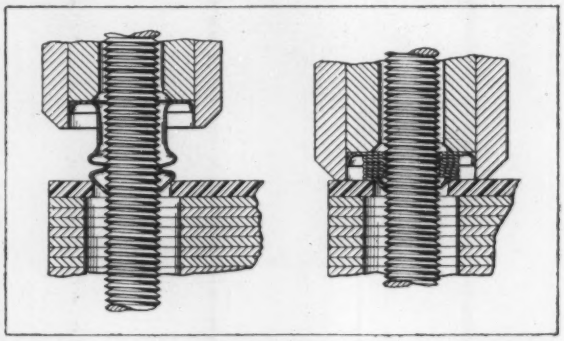
ing member, stress concentrations are reduced and fatigue failures are minimized. *Patent* 2,808,070 *assigned to Malsbary Mfg. Co. by Walter F. Malsbary.*

Pressed-On Locknut

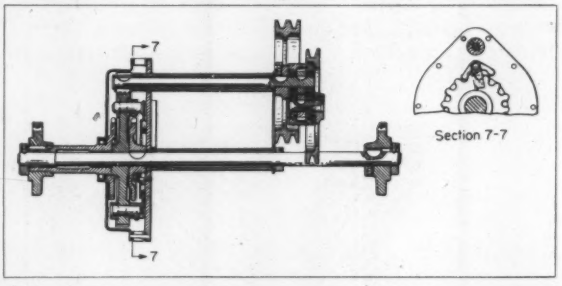
Adapted for automatic assembly of relatively small devices, a pressed-on fastener eliminates the need for spinning individual nuts into place. Initial form of the



unit is that of a pliable-metal thin-walled cylinder which is slipped over the bolt or stud. By means of a forming tool, the cylinder is then collapsed or accordioned against the threads to form a vibration-resistant assembly. Two stages of installation shown here illustrate the unit in initial collapse (left) and in final clinched form (right). *Patent* 2,807,083 *assigned to Radio Corp. of America by Patrick W. Zilliacus and Max Gersenson.*

Gearless Differential Drive

Precise maneuvering of light-duty construction or agricultural equipment is permitted by a gearless differential-drive assembly. Differential action, which



allows either wheel to overrun the other, is accomplished by dual pawl-and-ratchet mechanisms (Section 7-7) connecting the drive gear and the wheel shafts. Idler-tensioned V-belts (not shown) engage forward or reverse drive pulleys to provide power input to the drive-assembly counter shaft. *Patent* 2,756,615 *assigned to Great Lakes Tractor Co. by John J. Kantz Jr.*

Copies of patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.

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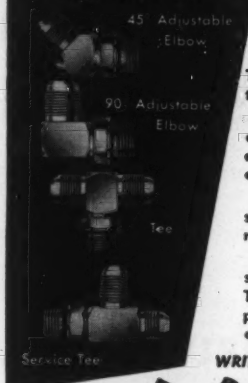

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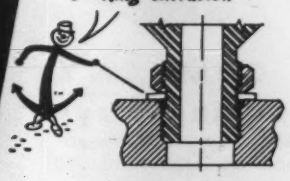

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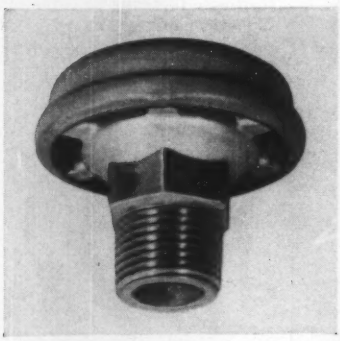

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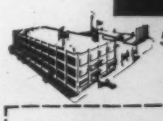

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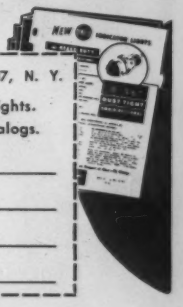

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Hardened tool steel ways, guides, and special wear plates, inseparably forge welded to tough, machineable backings. Hardness, shapes, dimensions, and mounting holes to your specifications.

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Parts I & II
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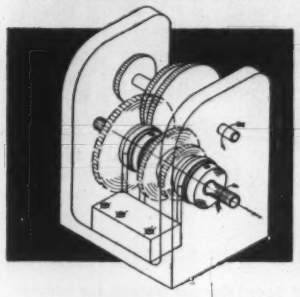

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"Alcoa bearing alloy is so good it's used for this compressor's main and crankpin bearings, too. And although bearing loads on compressors are well under 1000 psi, Alcoa alloy can take up to 10,000 psi where required."

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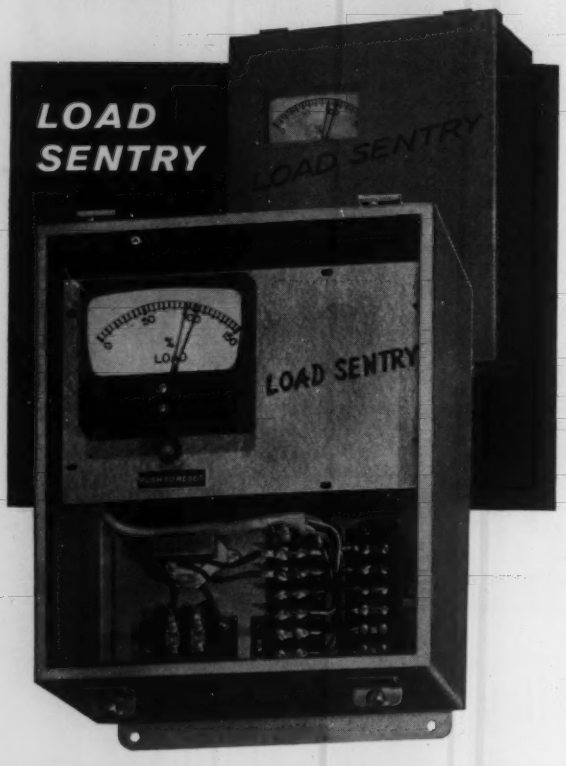

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With one pointer, you set the load limit anywhere on the dial. Another pointer shows running load on the motor. If an overload occurs, these pointers meet and a protective circuit is energized, or feed rate is changed, or the motor is shut down, as preferred.

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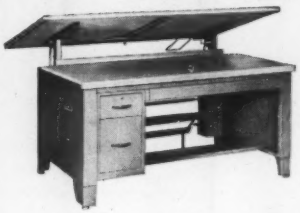

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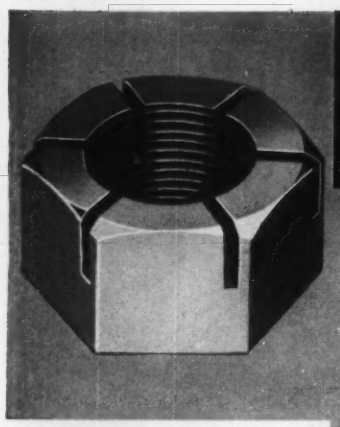
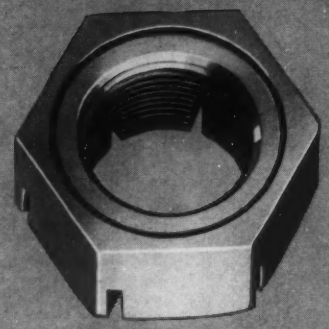
Circle 609 on Page 19

the
MARSDEN
free running lock nut





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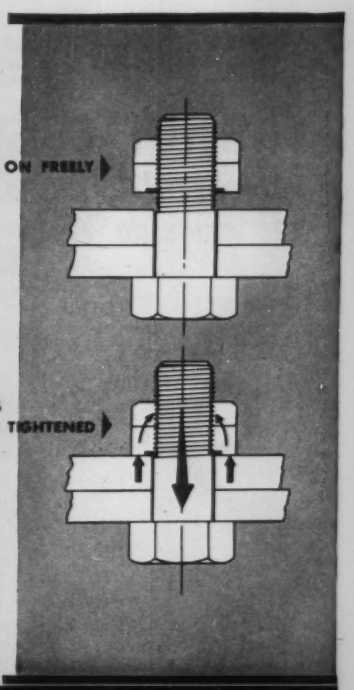

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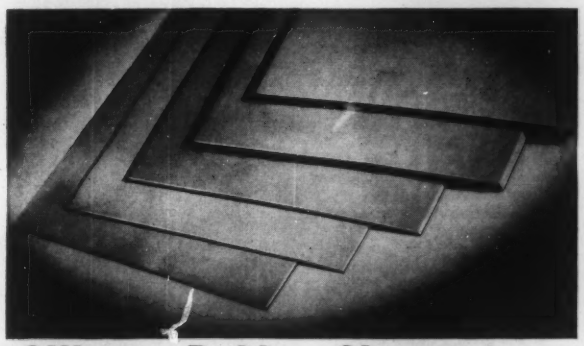

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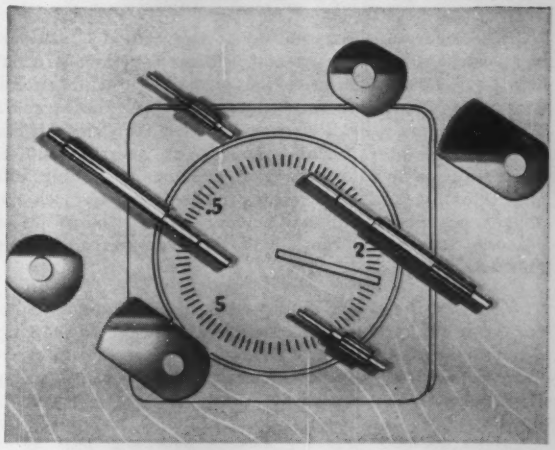

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help SCHRAMM Pneumatractor to amazing Work-Versatility

HUSCO hydraulic engineering is dramatically reflected in the design of seven special hydraulic cylinders which help to make the Schramm Self-Propelled Pneumatractor one of today's most versatile tools for the contractor. These cylinders provide hydraulic power for the Schramm Front End Loader, Backhoe and for an amazing number of operations—loading, digging, bulldozing, grading, filling, tamping, lifting, sweeping and for accessories like shovel buckets, tampers, blades, booms, snow plows, winches, trenchers, cranes, hole diggers, pumps, mowers, and many others.

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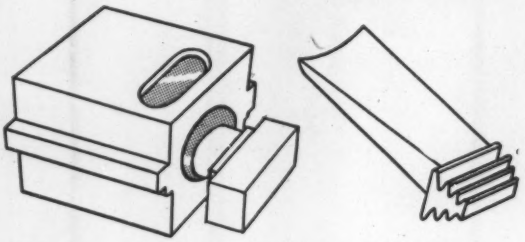

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Circle 615 on Page 19

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DeVilbiss Air Compressors to build into your product

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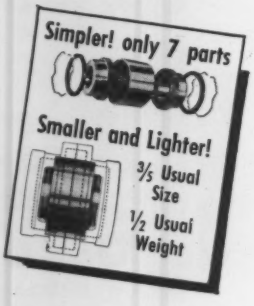

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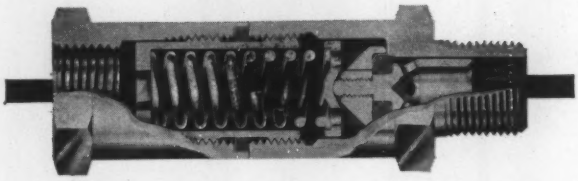

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- **ELECTRICAL**
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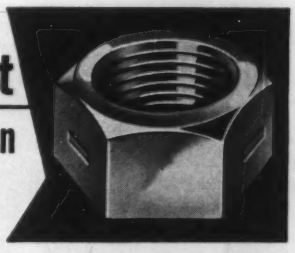
saves production time... speeds application



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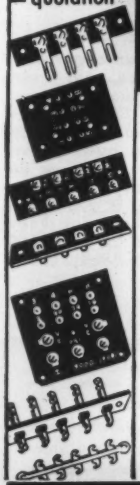

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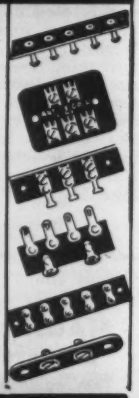

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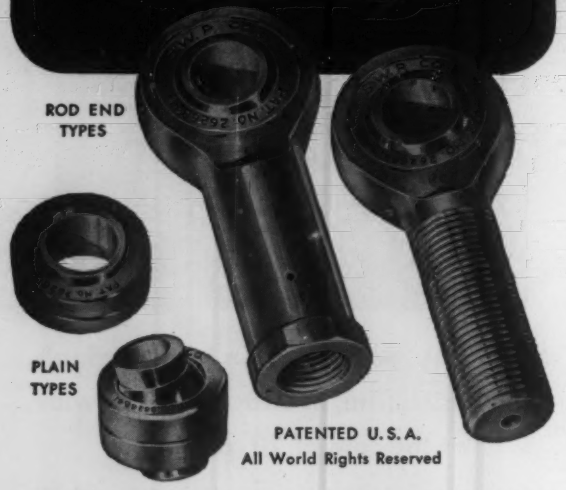

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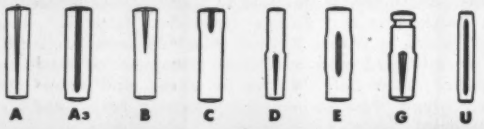

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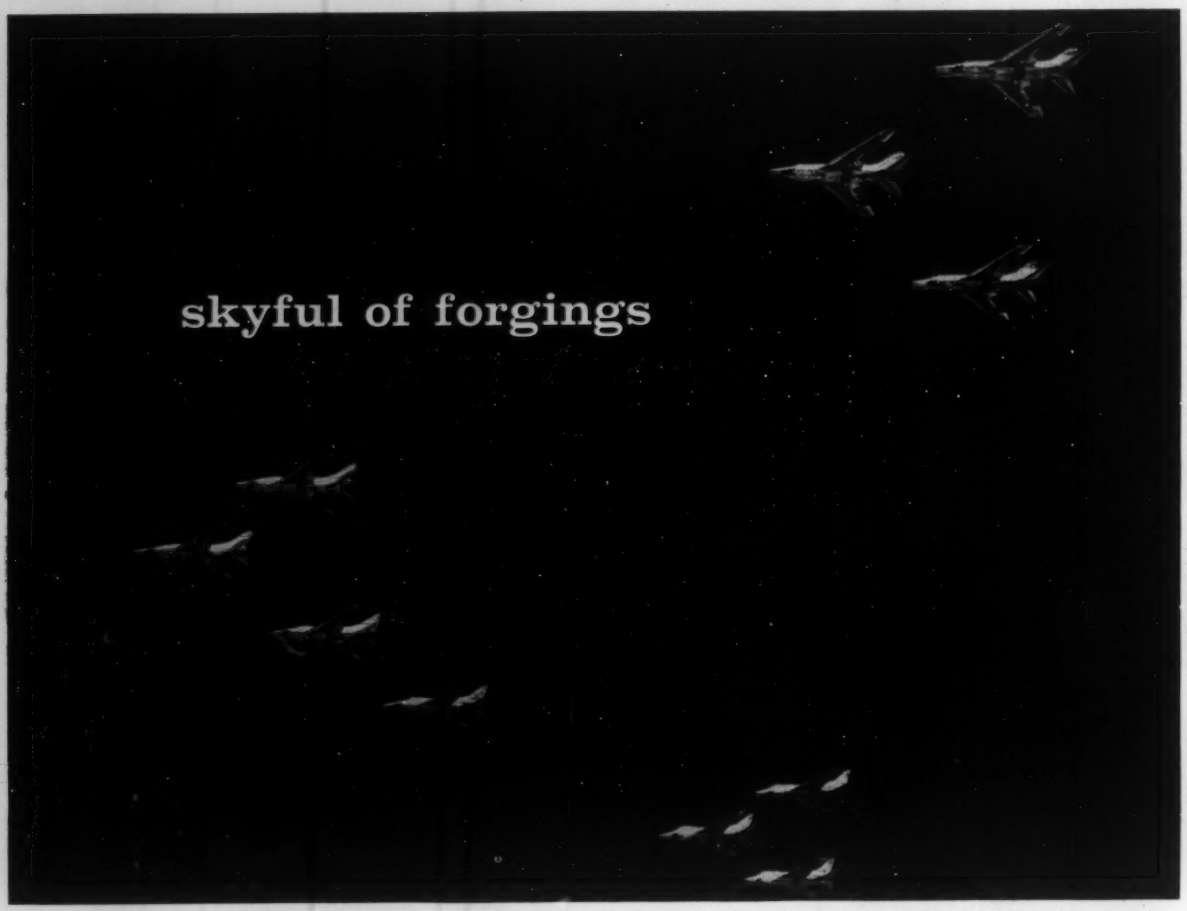

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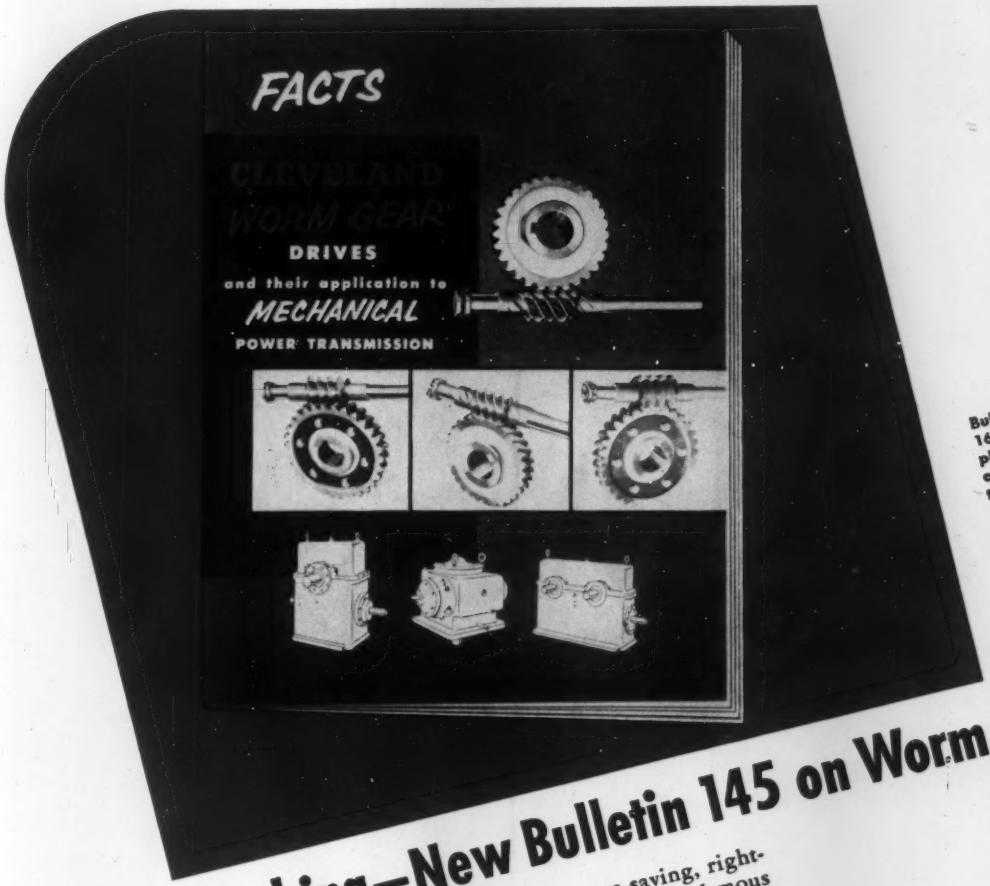

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